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VOL. IX • NO. 1 • JANUARY 1971

# DEVELOPMENT DIGEST

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National Planning Association  
1525 18th Street, N.W.  
Washington, D. C. 20036

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 2, 1966.

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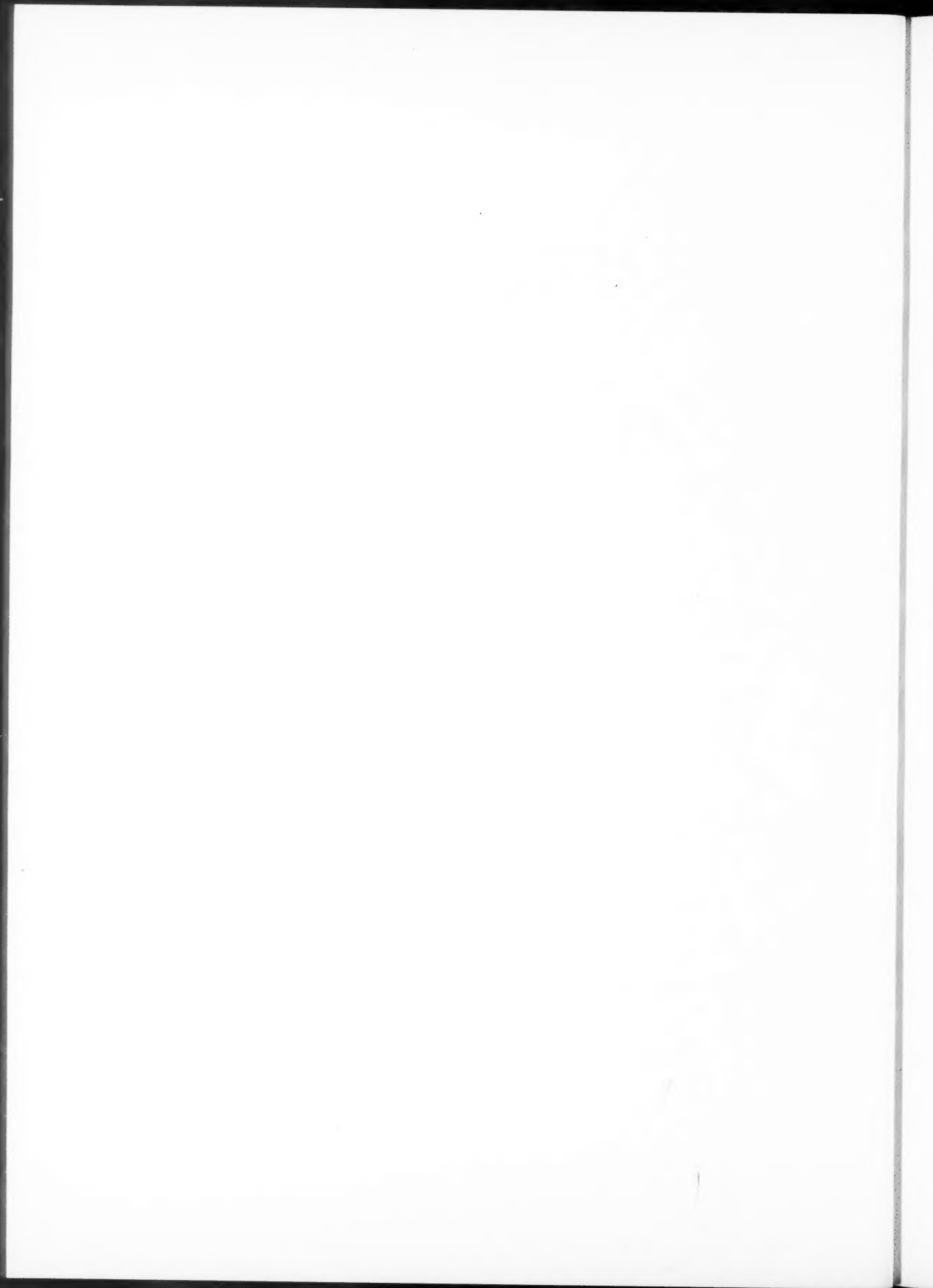
# DEVELOPMENT DIGEST

A quarterly journal of excerpts, summaries, and reprints  
of current materials on economic and social development

Gordon Donald, Editor; Pushpa Nand Schwartz, Associate Editor  
Prepared by the NATIONAL PLANNING ASSOCIATION

for

Agency for International Development, U. S. Department of State





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(Unless otherwise indicated,  
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## NOTICE

The United States Agency for International Development (AID), as a part of its continuing interest in economic improvement in the developing countries, has engaged in a modest research program in association with selected American universities and research institutions. In financing such research, AID has sought to obtain reports and data that would assist development officials in meeting typical problems they encounter. A list of the research papers available in economic fields may be obtained by writing to:

Economic Research Support Staff  
Bureau for Program and Policy Coordination  
Agency for International Development  
Washington, D. C. 20523, U.S.A.

Requests for individual papers may then be made from the same office by following the instructions attached to the list.

Some of the major research projects, each of which has produced a number of individual studies, are the following:

1. Harvard University: comparative studies on resource allocation, including those focusing on sectors--agriculture, transportation, manpower, industry, trade, planning, and overall structural change; on countries--Pakistan, Colombia, Korea, Greece, Argentina; or on policy issues--taxes, balance of payments, and others.
2. Yale University: quantitative study of economic structure and growth, including works on Brazil, the United Arab Republic, Ceylon, and others. Future studies will deal with employment creation and technological change.
3. National Planning Association: development planning and strategies, problems of trade, industry and finance, chiefly in countries of Southeast Asia. [See Development Digest, October 1970, pp. 106-124.]
4. Williams College: policy issues and economic data relating to import substitution, with emphasis on Latin American countries, Pakistan, and others.
5. RAND Corporation: studies covering, among other topics, Indian transportation, Peruvian agriculture, family planning in Puerto Rico, industry in Chile, and in Colombia--industry, education, unemployment, wages, internal migration, foreign exchange.

6. International Institute for Educational Planning: studies on the uses of cost analysis in education planning, including country studies in Uganda, Ivory Coast, Tanzania, Malagasy, Barbados, Morocco, Ceylon, India, Thailand, Chile, Brazil, Colombia.
7. University of Wisconsin: regional cooperation in South and Southeast Asia, with attention to population, trade and national development, merchant marine, tariffs and savings.

# ENVIRONMENT



FISH KILLED BY INDUSTRIAL WASTES  
DUMPED INTO STREAM  
[PHOTO: U.S. DEPARTMENT OF  
AGRICULTURE/W.E. SEIBEL]

# Problems of the Human Environment

Secretary General of the United Nations

[A broad survey of problems affecting the human environment suggests areas which need new national policies, and in some will require international cooperation. Many of the problems that afflict developed countries are also visible in developing nations.]

For most of the time that man has been on earth, his numbers have been small and his power limited. Damage to his environment was at worst local, and usually subject to repair by the regenerative powers of nature. It is estimated that in 1600 A. D. the numbers of men were no more than half a billion, and much of the world was uninhabited or little affected by man's activities. In these few centuries, the numbers of mankind have increased sevenfold and all areas on the earth's surface have been to some degree modified by man. With the prospect of another doubling of the world's population to 7 billion by 2000 A. D., the need to provide food, water, minerals, fuel and other necessities for such increasing numbers of people will place pressures upon virtually all areas of the earth and demand the most careful planning and management of natural resources. No nation can any longer be isolated from these global pressures. It has become clear that we all live in one biosphere within which space and resources, though vast, are limited.

Accompanying the growth of populations has been the spread of urbanization. Forty percent of the world's people now live in urban areas, and if present trends continue the great majority of people will live in towns and cities in somewhat more than half a century. The rate of urbanization is more rapid in the developing nations. Urbanization is not in principle destructive to the environment; however, in most areas, governments have neither prepared for, nor have they been able to cope with, the mass migration into urban areas.



In the large cities, slums of the most wretched nature often become the environment of people who once lived in greater dignity and better health on rural lands. Along with population growth and urbanization is the accelerated impact of industrialization, and of an advanced technology that is often poorly integrated with human needs and environmental necessities. In the most recent decade, the total value of all industrial production has doubled. Virtually all measures of industrialization show increasing rates. Industrialization is of vital importance to nations which seek to elevate the living standards of their people, and improved technology is necessary if productivity is to increase. However, the side effects of poorly planned or uncontrolled industrialization and of the one-sided application of technology have been a direct cause of many serious environmental problems.

Increasing populations also bring increasing demands upon the productivity of agricultural lands in order to meet needs for food and fiber. Application of technology to these lands has brought greatly increased production, and further gains in productivity must exceed the considerable progress already achieved if human misery is to be prevented. It is of great importance, however, that such gains be not offset by environmental deterioration. The land upon which man depends for his sustenance has been seriously impaired by many of his past activities and in many areas this process continues. It has been estimated that 500 million hectares of arable lands have already been lost through erosion and salinization, and that two thirds of the world's forest area has been lost to production; 150 types of birds and animals have become extinct through human agency, and another 1,000 species are considered to be rare or endangered. Erosion, soil deterioration, deforestation, and the destruction of animal and plant life continue and in some areas are accelerating.

The deterioration of the human environment may thus be related to three basic causes: accelerated population growth, increased urbanization, and an expanded and efficient new technology, with their associated increase in demands for space, food and natural resources. None of these need be damaging to the environment. However, the efforts to accommodate population, to integrate technology into complex environments, to plan and control industrialization and urbanization, and to properly manage land and resources, have fallen far short of those required. The main problems of the environment can be classified as follows: a) human settlements problems, for which action is primarily the responsibility of national, city and local authorities; b) territorial problems, for which action is primarily the responsibility of national governments; and c) global problems, amenable to solution only by international agreement.

#### Problems of Human Settlements

The environment of human settlements differs from others in the degree to which it is created and controlled by man. It is within one

of man's most impressive creations, the cities, that some of the most severe environmental problems occur. In most developing nations, it has rarely been possible to provide in advance the urban planning and design that would lead to a rational arrangement of space for living, working, transportation and recreation, or to provide rapidly enough housing, water, sewage disposal, education, or the other necessities or amenities of urban life. The very time factor involved in development of urban facilities is a major aggravating factor. Migration into cities is often associated with the importation of disease such as trachoma, tuberculosis, parasitosis and skin diseases. The influx of people tends to bring enormous pressure on water supplies and the arrangements for waste disposal, with the consequent appearance of diarrheal diseases. Overcrowding of premises and sites is typical, and further unsatisfiable demands are made upon water supply and waste disposal facilities. Food supplies may be inadequate, malnutrition is not uncommon, and in association with bowel infections is a common cause of death in young children born and living under those unsanitary conditions. Propinquity and overcrowding encourage upper respiratory infections and venereal disease. This pattern in the propagation of disease overtaxes the whole medical care organization.

In developed regions the urban environment is afflicted with many of the same difficulties encountered in developing regions when urban planning and design lag far behind urban growth. In addition, pollution is one of the most omnipresent characteristics of cities in developed nations. Air pollution resulting from the combustion of fossil fuels for space heating, industrial power, or transportation represents a danger to human health, causes damage to materials and structures, and impairs agricultural productivity in surrounding lands. Efforts of cities to cope with air pollution have not yet been fully effective; London, for example, has improved the quality of its air through restricting the use of coal and high sulphur petroleum, but has gained ever-increasing amounts of by-products from automobile exhausts. Water pollution in urbanized areas is a huge problem affecting developed as well as developing countries and will require expenditures of billions of dollars. Pollution from noise is having unknown effects on human health. Pollution from human wastes is of primary concern in developing regions. Water supplies are not only contaminated with human wastes, but grow increasingly toxic as they receive the effluent from burgeoning industries.

### Territorial Problems

Territorial problems include those arising from the lack of proper design, planning, control and management of land and water in non-urban continental areas. In the lands of the humid tropics, for example, shifting cultivation of areas at best marginal for agriculture causes serious difficulties. Many areas suffer in greater or less de-

gree from watershed damage, soil erosion, laterization (i. e., the hardening and sterility of many tropical soils when natural cover is removed), loss of soil fertility, destruction of valuable forest resources. In the dry tropics and sub-tropics the major original economic base has been a subsistence pastoralism with limited development of irrigated agriculture. The destruction of vegetation and soil and the advance of barren deserts, most often caused by inadequate control over the numbers and movement of livestock, is a continuing process. Efforts to improve carrying capacity for livestock through water development are often defeated by failure to provide control over livestock concentrations. The problems of nomadic people have generally not been solved in ways suitable either to the nomads or the total environment. The choice among alternative uses of limited water resources, particularly in relation to irrigation, has not often been made on a rational basis optimizing costs and benefits with long-term economic returns, conservation of water and of soils, and proper social and health adjustments.

Most of the nations of the developed world are centered in the temperate zone where stable patterns of land use have been developed over centuries. Despite this, there appears a widespread imbalance between efforts to further enhance economic productivity and efforts to maintain a stable or improving environment. Conflicts between the demands of the urban-industrial centers for water, power, transportation networks and space for buildings, on the one hand, and the necessity of maintaining rural productivity and rural amenities, on the other, are widespread. The sub-arctic and arctic regions form an undeveloped part of the developed nations. As yet, the environmental problems resulting from human activity are few, but all are widely shared. These include protection and rational use of the resources of the sea; development of a suitable economic base and social environment for the indigenous peoples of these regions; protection of wildlife; proper management of forest resources; enhancement of agricultural productivity through new varieties of crops and new techniques of production; and development of fuel and mineral resources without environmental damage.

Of particular interest among territorial problems are those arising from large-scale construction of dams, reservoirs, canals, power stations and other structures for the movement and control of water in major river basins or the transfer of water from one basin to another, to provide for power, irrigation, transport or urban water supplies. Although economic and engineering factors are given full weight, the broader environmental impact is inadequately considered. Often little or no attention is given to proper management of lands in the watersheds developed by these engineering techniques. Among the deleterious effects that occur are siltation of reservoirs, loss of delta lands, salinization, spread of waterborne diseases and displace-

ment of peoples. The need for more adequate analysis of total environmental costs and benefits is apparent.

Different industries have different effects on the territorial environment. Many of them, such as paper mills and chemical plants, have serious consequences on water pollution. The mining industry in some countries has long ago been forced by legislation or economic necessity to take remedial action, such as storing tailings behind dams to protect agricultural lands downstream. Copper smelter operators in Tennessee and in Peru, who were devastating the vegetation over large areas with acid fumes, have now set up plants to make acid from fumes. Since smelter dust often contains valuable by-products, many operators have now installed dust treatment equipment. Slag from the steel industry is used on construction, and over 2.5 million tons of fertilizer were produced in 1967 in France alone, using the Thomas slag which has a high phosphorous content. Pollution of rivers and lakes is obviously a major problem of the greatest concern; virtually every stream and lake in urbanized and industrialized regions is heavily affected by urban and industrial pollution. Thermal pollution is becoming of greater concern since it can be expected to increase with the growing development of nuclear power.

Soils are polluted in agricultural regions by the intense use of certain fertilizers as well as by biocides and the effects of long-lasting, broad-spectrum pesticides are most notable. The maintenance of both atmospheric oxygen and the productivity of marine environments depends upon photosynthesis by marine plants, mostly the floating algae of microscopic size. Minute amounts of such pesticides as DDT have been found to inhibit photosynthesis in these algae by 75 percent. Nevertheless, an estimated billion pounds of DDT have been dumped into our environment and some 100 million pounds are added each year. The total world production of pesticides is estimated at over 1,300 million pounds annually, and many of these have known effects upon fish, wildlife and human health, which have been of serious consequence in certain areas. [See "The Pesticide Controversy," Development Digest, October 1970, pp. 43-55.]

Planning for one segment of the economy often fails to take into account the needs of others. Transportation networks are developed to the detriment of farm lands, wet lands, scenic areas and other rural resources. The exploitation of forests for timber may fail to take into account the values of forests for recreation, tourism, wildlife and the maintenance of stream quality and fisheries productivity. Biocides used on farm lands produce damage to other resources over wide regions. The development of waterways for power, irrigation or transportation may proceed with little regard for aesthetic or conservation requirements in the human environment. Better land use planning and control is needed everywhere.

In the developing countries, which are primarily concerned in developing their agricultural, mineral and water resources, one of the main problems in taking corrective and ameliorative action is the need for recognition that regulation is not a restriction but is an integral part of the long-term and sustained development of resources and the environment, and should be considered even in the earliest stages of development. Countries embarking on industrialization should foresee problems and not repeat the unfortunate experiences of the more industrialized nations. There is therefore urgent need for prompt action in all countries to develop and strengthen regulatory services, legislation, and laboratories for analytical control as well as for research; public information and education are equally important in arousing awareness and obtaining cooperation from the general public.

### Global Problems

Many national parks, nature reserves, undisturbed islands and wild species have value as part of a world heritage of wild and scenic resources. Their proper conservation becomes an international obligation which must be exercised in concert with the national agencies having responsibility over them. Many birds, marine mammals, and marine reptiles are migratory by nature and can only be protected through international agreement. The greatest apparent man-made changes in biological environments are those related to pollution. These include the increase in carbon dioxide, particulate matter, and various toxic and radioactive materials in the atmosphere which could have long-term deleterious effects and must be studied and where necessary controlled. Water pollution may also be a global problem, as may the release of radioactive isotopes, the discharge of toxic materials, excessive nutrients, or heated water into estuaries of coastal waters on which the productivity of the oceans is dependent. Pollution from radioactive material is a danger which could become of greater significance as increased reliance is placed on nuclear power and, eventually, if nuclear explosives for engineering purposes are to be used. Although some measures have been taken by the nuclear industry, all possible contamination problems have not yet been fully solved; Krypton 85 and tritium are of particular concern in this respect.

In the marine environment there is an obvious need for international control over the exploitation of marine resources and for the institution of rational use of the resources of the sea. Destruction or depletion of marine resources has been a continuing process in the absence of effective control and management. The decline of certain species of whales and seals, of sea turtles, of the Pacific sardine and Atlantic salmon fisheries, as well as the continuing overexploitation of the eastern Pacific anchoveta fishery are examples. The



growing dependence of mankind upon the sea as a source of protein requires that its resources be properly managed. Pollution of the sea is a continual threat to its future productivity. Although the International Convention for the Prevention of Pollution of the Sea by Oil has been in existence since 1954, oil pollution remains a major concern, and other forms of equally damaging pollution continue with little or no control.

Weather and climate are widely recognized as fundamental elements of the human environment. The use of meteorological and climatological data for planning for efficient use of the land, for water resources, agriculture, and human settlements is not as yet receiving adequate attention. The need for continual monitoring to detect changes in the earth's atmosphere and its weather and climate is also apparent, but projects under way such as the World Weather Watch, still require more adequate support.

Both at national and international levels, action programs and institutional measures to correct and prevent pollution of the air, of land, water and ocean resources, and of food, are urgently needed. So are legislative and administrative controls, in the interest of both social and economic objectives, on the use of pesticides and other chemicals which are essential in modern agriculture and industry but which, when wrongly used, can be harmful to man and his environment.

[Excerpted from Problems of the Human Environment: Report of the Secretary General. New York: United Nations, 26 May 1969, pp. 4-16. UN Document No. E/4667.]

## The Economics of the Coming Spaceship Earth

Kenneth E. Boulding

[New thinking about economics is needed as we move closer to the earth's finite capacity to support ever-expanding production and consumption levels. More stress should be given to the maintenance of stocks as an economic goal rather than consumption per se, and to the future as against the present.]

The closed earth of the future requires economic principles which are somewhat different from those of the open earth of the past. I will call the open economy the "cowboy economy," the cowboy being symbolic of the illimitable plains and also associated with reckless, exploitative, romantic, and violent behavior, which is characteristic of open societies. The closed economy of the future might be called the "spaceship economy," in which the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy. The difference between the two types of economy becomes most apparent in the attitude towards consumption. In the cowboy economy, consumption is regarded as a good thing and production likewise; and the success of the economy is measured by the amount of the throughput from the "factors of production," a part of which, at any rate, is extracted from the reservoirs of raw materials and non-economic objects, and another part of which is output into the reservoirs of pollution. If there are infinite reservoirs from which material can

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be obtained and into which effluvia (i. e., harmful waste products) can be deposited, then the throughput is at least a plausible measure of the success of the economy. The gross national product (GNP) is a rough measure of this total throughput. It should be possible, however, to distinguish that part of the GNP which is derived from exhaustible and that which is derived from reproducible resources, as well as that part of consumption which represents effluvia and that which represents input into the productive system again. Nobody, as far as I know, has ever attempted to break down the GNP in this way, although it would be an important exercise.

By contrast, in the spaceman economy, throughput is by no means desirable, and is indeed to be regarded as something to be minimized rather than maximized. The essential measure of the success of the economy is not production and consumption at all, but the nature, extent, quality, and complexity of the total capital stock, including in this the state of the human bodies and minds in the system. In the spaceman economy, what we are primarily concerned with is stock maintenance, and any technological change which results in the maintenance of a given total stock with a lessened throughput (that is, less production and consumption) is clearly a gain. This idea that both production and consumption are bad things rather than good things is very strange to economists, who have been obsessed with the income-flow concepts to the exclusion, almost, of capital-stock concepts.

There are some very tricky and unsolved problems involved in the questions as to whether human welfare or well-being is to be regarded as a stock or a flow. Something of both these elements seems actually to be involved in it, and as far as I know there have been practically no studies directed towards identifying these two dimensions of human satisfaction. Is it, for instance, eating that is a good thing, or is it being well fed? Does economic welfare involve having nice clothes, fine houses, good equipment, and so on, or is it to be measured by the depreciation and the wearing out of these things? I am inclined myself to regard the stock concept as most fundamental, that is, to think of being well fed as more important than eating, and to think even of so-called services as essentially involving the restoration of a depleting psychic capital. Thus I have argued that we go to a concert in order to restore a psychic condition which might be called "just having gone to a concert," which, once established, tends to depreciate. When it depreciates beyond a certain point, we go to another concert in order to restore it. If it depreciates rapidly, we go to a lot of concerts; if it depreciates slowly, we go to few. Similarly, we eat primarily to restore bodily homeostasis, that is, to maintain a condition of being well fed, and so on. On this view, there is nothing desirable in consumption at all. The less consumption we can maintain a given state with, the better off we are. If we had clothes that did not wear out, houses that did not depreciate, and even

if we could maintain our bodily condition without eating, we would clearly be much better off.

It is this last consideration, perhaps, which makes one pause. Would we, for instance, really want an operation that would enable us to restore all our bodily tissues by intravenous feeding while we slept? Is there not, that is to say, a certain virtue in throughput itself, in activity itself, in production and consumption itself, in raising food and in eating it? It would certainly be rash to exclude this possibility. Further interesting problems are raised by the demand for variety. We certainly do not want a constant state to be maintained; we want fluctuations in the state. Otherwise there would be no demand for variety in food, for variety in scene, as in travel, for variety in social contact, and so on. The demand for variety can, of course, be costly, and sometimes it seems to be too costly to be tolerated or at least legitimated, as in the case of marital partners, where the maintenance of a homeostatic state in the family is usually regarded as much more desirable than the variety and excessive throughput of the libertine. There are problems here which the economics profession has neglected with astonishing singlemindedness. My own attempts to call attention to some of them, as far as I can judge, produced no response whatever; and economists continue to think and act as if production, consumption, throughput, and the GNP were the sufficient and adequate measure of economic success.

It may be said, of course, why worry about all this when the space-man economy is still a good way off (at least beyond the lifetimes of any now living), so let us eat, drink, spend, extract and pollute, and be as merry as we can, and let posterity worry about the spaceship earth. It is always a little hard to find a convincing answer to the man who says, "What has posterity ever done for me?" and the conservationist has always had to fall back on rather vague ethical principles postulating identity of the individual with some human community or society which extends not only back into the past but forward into the future. Unless the individual identifies with some community of this kind, conservation is obviously "irrational." Why should we not maximize the welfare of this generation at the cost of posterity? The only answer to this, as far as I can see, is to point out that the welfare of the individual depends on the extent to which he can identify himself with others, and that the most satisfactory individual identity is that which identifies not only with a community in space but also with a community extending over time from the past into the future. If this kind of identity is recognized as desirable, then posterity has a voice. This whole problem is linked up with the much larger one of the determinants of the morale, legitimacy, and "nerve" of a society, and there is a great deal of historical evidence to suggest that a society which loses its identity with posterity and which loses its positive image of the future loses also its capacity to deal with present problems, and soon falls apart.

Even if we concede that posterity is relevant to our present problems, we still face the question of time-discounting and the closely related question of uncertainty-discounting. It is a well-known phenomenon that individuals do discount the future, even in their own lives. This may explain why conservationist policies almost have to be sold under some other excuse which seems more urgent, and why, indeed, necessities which are visualized as urgent, such as defense, always seem to hold priority over those which involve the future. But there is no sure guide to just what percentage rate of discount ought to be used, either for the passage of time per se or for the probability that present calculations will turn out to be wrong when the predicted future events actually arrive. In any case, new technical knowledge, or new priorities, may have intervened.

All these considerations add some credence to the point of view which says that we should not worry about the spaceman economy at all, and that we should just go on increasing the GNP and indeed the gross world product, or GWP, in the expectation that the problems of the future can be left to the future; that when scarcities arise, whether of raw materials or of pollutable reservoirs, the needs of the then present will determine the solutions of the then present, and there is no use giving ourselves ulcers by worrying about problems that we really do not have to solve. As an old taker of thought for the morrow, however, I cannot quite accept this view; and I would argue, furthermore, that tomorrow is not only very close, but in many respects it is already here. The shadow of the future spaceship, indeed, is already falling over our spendthrift merriment. Oddly enough, it seems to be in pollution rather than in exhaustion that the problem is first becoming salient. Los Angeles has run out of air, Lake Erie has become a cesspool, the oceans are filling up with lead and DDT, and the atmosphere may become man's major problem in another generation at the rate at which we are filling it up with gunk. It is, of course, true that at least on a microscale, things have been worse at times in the past. The cities of today, with all their foul air and polluted waterways, are probably not as bad as the filthy cities of the pretechnical age. Nevertheless, that fouling of the nest which has been typical of man's activity in the past on a local scale now seems to be extending to the whole world society; and one certainly cannot view with equanimity the present rate of pollution of any of the natural reservoirs, whether the atmosphere, the lakes, or even the oceans.

[Excerpted from Environmental Quality in a Growing Economy: Essays from the Sixth Resources for the Future Forum. Baltimore (Md.): the Johns Hopkins Press, Henry Jarrett (ed.), 1966, pp. 3-14; published for Resources for the Future, Inc. Copyright © 1966 by the Johns Hopkins Press. Reprinted with Permission.]

## Human Food Production in the Biosphere

Lester R. Brown

[Man's efforts to expand his food supply to feed his rapidly expanding numbers are beginning to press on the limits of the earth's environment. Elimination of destructive or wasteful processes, and adjustments to overall resource limitations are becoming increasingly important.]

Throughout most of man's existence his numbers have been limited by the supply of food. For the first two million years or so he lived by hunting, fishing, and gathering plant products. Under such circumstances the biosphere, i. e., the life-sustaining envelope of the earth's atmosphere, water and land surface, could not support a human population of more than 10 million, a population smaller than that of London or Afghanistan today. Then, with his domestication of plants and animals some 10,000 years ago, man began to shape the biosphere to his own ends.

As primitive techniques of crop production and animal husbandry became more efficient the earth's food-producing capacity expanded, permitting increases in man's numbers. It took two million years for the human population to reach the one-billion mark, but the fourth billion now being added will require only 15 years: from 1960 to 1975. The enormous increase in the demand for food that is generated by this expansion in man's numbers, together with rising incomes, is beginning to have disturbing consequences. The continuing expansion of land under the plow and the evolution of a chemically oriented modern agriculture are producing

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ominous alterations in the biosphere not just on a local scale but, for the first time in history, on a global scale as well. The decision by a government to dam a river, by a farmer to use DDT on his crops or by a married couple to have another child, thereby increasing the demand for food, has repercussions for all mankind.

The revolutionary change in man's role from hunter and gatherer to tiller and herdsman took place in circumstances that are not well known, but some of the earliest evidence of agriculture is found in the hills and grassy plains of the Fertile Crescent in Iraq and Syria. The cultivation of food plants and the domestication of animals were aided there by the presence of wild wheat, barley, sheep, goats, pigs, cattle and horses. Today crops, replacing the original cover of grass or forest, occupy some three billion acres. This amounts to about 10 percent of the earth's total land surface and a considerably larger fraction of the land capable of supporting vegetation, that is, the area excluding deserts, polar regions and higher elevations. Two thirds of the cultivated cropland is planted to cereals.

### New Technologies

Modern agriculture depends heavily on four technologies: mechanization, irrigation, fertilization and the chemical control of weeds, diseases, and insects. Each of these technologies has made an important contribution to the earth's increased capacity for sustaining human populations, and each has perturbed the cycles of the biosphere.

As early as 3000 B. C. the farmers of the Middle East learned to harness draft animals to help them till the soil. It enabled man to greatly augment his own limited muscle power and to convert roughage (indigestible by humans) into a usable form of energy and thus to free some of his energy for pursuits other than the quest for food. The invention of the internal-combustion engine and the tractor 5,000 years later provided a much greater breakthrough. The replacement of horses by the tractor not only provided the farmer with several times as much power but also released 70 million acres in the U. S. , for example, that had been devoted to raising feed for horses.

In the highly mechanized agriculture of today the expenditure of fossil fuel energy per acre is often substantially greater than the energy yield embodied in the food produced. This deficit in the output is of no immediate consequence, because the system is drawing on energy in the bank. When fossil fuels become scarcer, man will have to turn to some other source of motive energy for agriculture: perhaps nuclear energy or some means, other than photosynthesis, of harnessing solar energy.



## Soil Erosion

The combination of draft animals and mechanical power has given man an enormous capacity for altering the earth's surface by bringing additional land under the plow--not all of it suited for cultivation. In addition, in the poorer countries his expanding need for fuel has forced him to cut forests far in excess of their ability to renew themselves. The areas largely stripped of forest include mainland China and the subcontinent of India and Pakistan, where much of the population must now use cow dung for fuel. Livestock populations providing draft power, food and fuel tend to increase along with human populations, and in many poor countries the needs of livestock for forage far exceed its self-renewal, gradually denuding the countryside of grass cover. As population pressure builds, not only is more land brought under the plow but also the land remaining is less suited to cultivation. Once valleys are filled, farmers begin to move up hillsides, creating serious soil-erosion problems. As the natural cover that retards runoff is reduced and soil structure deteriorates, floods and droughts become more severe.

Over most of the earth the thin layer of topsoil producing most of man's food is measured in inches. Soil is produced by the weathering of rock, and the process takes several centuries to form an inch of topsoil. Denuding the land of its year-round natural cover of grass or forest exposes this thin mantle of life-sustaining soil to rapid erosion by wind and water. Much of the soil ultimately washes into the sea; some of it is lifted into the atmosphere. Man's actions are causing the topsoil to be removed much faster than it is formed. This unstable relationship between man and the land from which he derives his subsistence obviously cannot continue indefinitely.

Robert R. Brooks of Williams College gives a wry description of the process occurring in the state of Rajasthan, India, where tens of thousands of acres of rural land are being abandoned yearly because of the loss of topsoil: "Overgrazing by goats destroys the desert plants which might otherwise hold the soil in place. Goatherds equipped with sickles attached to 20-foot poles strip the leaves of trees to float downward into the waiting mouths of famished goats and sheep. The trees die and the soil blows away 200 miles to New Delhi, where it comes to rest in the lungs of its inhabitants and on the shiny cars of foreign diplomats."

Soil erosion also impairs irrigation systems. This is illustrated in the Mangla irrigation reservoir in West Pakistan. On the basis of feasibility studies indicating that the reservoir could be expected to have a lifetime of at least 100 years, \$600 million was recently invested in the construction of the reservoir. Denuding and erosion of the soil in the watershed, however, accompanying a rapid growth of

population in the area, has already washed so much soil into the reservoir that it is now expected to be completely filled with silt within 50 years.

A historic example of the effects of man's abuse of the soil is all too plainly visible in North Africa, which once was the fertile granary of the Roman Empire and now is largely a desert or near-desert whose people are fed with the aid of food imports. In the U.S. the "dust bowl" experience of the 1930s remains a vivid lesson on the folly of overplowing. More recently the U.S.S.R. repeated this error, bringing 100 million acres of virgin soil under the plow only to discover that the region's rainfall was too scanty to sustain continuous cultivation. Once moisture reserves in the soil were depleted the soil began to blow.

Soil erosion is one of the most pressing and most difficult problems threatening the future of the biosphere. Each year it is forcing the abandonment of millions of acres of cropland in Asia, the Middle East, North Africa and Central America. The only possible remedy is to find ways to conserve the topsoil more effectively. The dust-bowl era in the U.S. ended in the 1930s with the widespread adoption of conservation practices by farmers. Twenty million acres were fallowed to accumulate moisture, and thousands of miles of trees for windbreaks were planted across the Great Plains. Fallow land was alternated with strips of wheat to reduce the blowing of soil while the land was idle. The densely populated countries of Asia, however, will find it difficult to adopt such tactics. Their food needs are so pressing that they cannot afford to take large areas out of cultivation; moreover, they do not yet have the financial resources or the technical skills for the immense projects in reforestation, controlled grazing of cattle, terracing, contour farming and systematic management of watersheds that would be required to preserve their soil.

### Irrigation

Irrigation, which agricultural man began to practice at least as early as 6,000 years ago, even earlier than he harnessed animal power, has played its great role in increasing food production by bringing into profitable cultivation vast areas that would otherwise be unusable or only marginally productive. Most of the world's irrigated land is in Asia, where it is devoted primarily to the production of rice.

During the past few years there has been an important new irrigation development in Asia: the widespread installation of small-scale irrigation systems on individual farms. In Pakistan and India, where in many places the water table is close to the surface, hundreds of thousands of tube wells with pumps have been installed in recent years. This development came about partly as an answer to a problem that



had been presented by irrigation itself. Over a period of time the percolation of irrigation water downward and the accumulation of this water underground may gradually raise the water table until it is within a few feet or inches of the surface. This not only inhibits the growth of plant roots by waterlogging but also results in the surface soil's becoming salty as water evaporates through it, leaving a concentrated deposit of salts in the upper few inches which makes agriculture impossible. Such a situation developed in West Pakistan. Tube wells lower the water table by tapping the ground water for intensive irrigation. Discharging this water on the surface, the wells also wash the soil's salt downward. The stratagem has worked, and the salty, waterlogged land of Pakistan is steadily being reclaimed [see pp. 26-27 below].

Other side effects of river irrigation are not so easily remedied. Such irrigation has brought about a great increase in the incidence of schistosomiasis, a disease that is particularly prevalent in the river valleys of Africa and Asia. The incidence of the disease is rising rapidly as the world's large rivers are harnessed for irrigation, and today schistosomiasis is estimated to afflict 250 million people. It now surpasses malaria, the incidence of which is declining, as the world's most prevalent infectious disease [see pp. 27-28 below].

As a necessity for food production water is of course becoming an increasingly crucial commodity. The projected increases in population and in food requirements will call for more and more water, forcing man to consider still more massive and complex interventions in the biosphere. The desalting of seawater for irrigation purposes is one major departure from traditional practices. Another is a Russian plan to reverse the flow of four rivers currently flowing northward and emptying into the Arctic Ocean. These rivers would be diverted southward into the semiarid lands of southern Russia, greatly enlarging the irrigated area of the U.S.S.R. Some climatologists are concerned, however, that the shutting off of the flow of relatively warm water from these four rivers would have far-reaching implications for not only the climate of the Arctic but also the climatic system of the entire earth.

Representing an even greater intervention in the biosphere is the prospect that man may one day consciously alter the earth's climatic patterns, shifting some of the rain now falling on the oceans to the land. Among the steps needed for the realization of such a scheme are the construction of a comprehensive model of the earth's climatic system and the development of a computational facility capable of simulating and manipulating the model. The required information includes data on temperatures, humidity, precipitation, the movement of air masses, ocean currents and many other factors that enter into the weather; earth-orbiting satellites will doubtless be able to collect much of this information. For the control of rainfall, there will be a

further requirement: the project will have to be managed by a global and supranational agency if it is not to lead to weather wars among nations working at cross purposes. Some commercial firms are already in the business of local rainmaking, and they are operating on an international basis.

### Fertilizers

The third great technology that man has introduced to increase food production is the use of chemical fertilizers. Such fertilizers did not come into widespread use until this century; one of the first countries to intensify its agriculture, largely by the use of fertilizers, was Japan, whose output of food per acre has steadily risen (except for wartime interruptions) since the turn of the century. The output per acre of a few other countries, including the Netherlands, Denmark and Sweden, began to rise at about the same time. The U.S., richly endowed with vast farmlands, did not turn to the heavy use of fertilizer and other intensive measures until about 1940; since then its yields per acre have also shown remarkable gains.

Experience has demonstrated that in areas of high rainfall the application of chemical fertilizers in conjunction with other inputs and practices can double, triple or even quadruple the productivity of intensively farmed soils. The use of chemical fertilizers is estimated to account for at least a fourth of man's total food supply. The world's farmers are currently applying 60 million metric tons of plant nutrients per year, an average of nearly 45 pounds per acre for the three billion acres of cropland. Such application, however, is unevenly distributed, and some poor countries do not yet benefit from the use of fertilizer in any significant amounts. If global projections of population and income growth materialize, the production of fertilizer over the remaining three decades of this century must almost triple to satisfy food demands.

Can the projected demand for fertilizer be met? The key ingredient is nitrogen, and fortunately man has learned how to speed up the fixation phase of the nitrogen cycle. Chemists have devised various ways of incorporating nitrogen from the air into inorganic compounds and making it available in the form of nitrogen fertilizers. These processes produce the fertilizer much more rapidly and economically than the growing of leguminous-plant sources such as clover, alfalfa or soybeans. More than 25 million tons of nitrogen fertilizer is now being synthesized and added to the earth's soil annually.

The other principal ingredients of chemical fertilizer are the minerals potassium and phosphorus. Unlike nitrogen, these elements are not replenished by comparatively fast natural cycles. Potassium presents no immediate problem; the rich potash fields of Canada

alone are estimated to contain enough potassium to supply mankind's needs for centuries to come. The reserves of phosphorus, however, are not nearly so plentiful as those of potassium. Every year 3.5 million tons of phosphorus washes into the sea, where it remains as sediment on the ocean floor. Eventually it will be thrust above the ocean surface again by geologic uplift, but man cannot wait that long. Phosphorus may be one of the first necessities that will prompt man to begin to mine the ocean bed.

The great expansion of the use of fertilizers in this century has benefited mankind enormously, but the benefits are not unalloyed. The runoff of chemical fertilizers into rivers, lakes and underground waters creates two important hazards. One is the chemical pollution of drinking water; in certain areas in Illinois and California the nitrate content of well water has risen to a toxic level. This hazard is of only local dimensions and can be countered by finding alternative sources of drinking water. A much more extensive hazard is the phenomenon called eutrophication. Inorganic nitrates and phosphates discharged into lakes and other bodies of fresh water provide a rich medium for the growth of algae; the massive growth of the algae in turn depletes the water of oxygen and thus kills off the fish life. In the end the eutrophication, or overfertilization, of the lake slowly brings about its death as a body of fresh water, converting it into a swamp. In the U.S. Lake Erie is a prime example of this process now under way.

A way must be found to deal with the eutrophication problem because even in the short run it can have damaging effects, affecting as it does the supply of potable water, the cycles of aquatic life and consequently man's food supply. How much of the now widespread eutrophication of fresh waters is attributable to agricultural fertilization and how much to other causes remains an open question. Undoubtedly the runoff of nitrates and phosphates from farmlands plays a large part. There are also other important contributors, however. Considerable amounts of phosphate, coming mainly from detergents, are discharged into rivers and lakes from sewers carrying municipal and industrial wastes. And there is reason to believe that in some rivers and lakes most of the nitrate may come not from fertilizers but from automobile engines.

### Pesticides

Recent findings have presented us with a related problem in connection with the fourth technology supporting man's present high level of food production: the chemical control of diseases, insects and weeds. It is now clear that the use of DDT and other chlorinated hydrocarbons as pesticides and herbicides is beginning to threaten many species of animal life, possibly including man. DDT today is

found in the tissues of animals over a global range of life forms and geography from penguins in Antarctica to children in the villages of Thailand. There is strong evidence that it is on the way to extinguishing some animal species, notably predatory birds whose capacity for using calcium is so impaired by DDT that the shells of their eggs are too thin to avoid breakage in the nest before the fledglings hatch. Concentrations of DDT in mothers' milk in the U.S. now exceed the tolerance levels established for foodstuffs by the Food and Drug Administration.

Several new approaches to the problem of controlling pests are now being explored. Chemists are searching for pesticides that will be degradable, instead of long-lasting, after being deposited on vegetation or in the soil, and that will be aimed at specific pests rather than acting as broad-spectrum poisons for many forms of life. Much hope is placed in techniques of biological control, such as are exemplified in the mass sterilization by irradiation of male screwworm flies. Successes are also being achieved in breeding resistance to insect pests in various crops. Another promising approach, which already has a considerable history, is the development of insect parasites, ranging from bacteria and viruses to wasps that lay their eggs in other insects. The fact remains, however, that the biological control of pests is still in its infancy. [See Development Digest, October 1970, pp. 43-62.]

### Prospect

What is the present balance sheet on the satisfaction of human food needs? Although man's food supply has expanded several hundred-fold since the invention of agriculture, two thirds of mankind is still hungry and malnourished much of the time. On the credit side a third of mankind, living largely in North America, Europe, Australia and Japan, has achieved an adequate food supply, and for the remaining two thirds the threat of large-scale famine has recently been removed, at least for the immediate future. In spite of rapid population growth in the developing countries since World War II, their peoples have been spared from massive famine (except in Biafra) by huge exports of food from the developed countries. As a result of two consecutive monsoon failures in India, a fifth of the total U.S. wheat crop was shipped to India in both 1966 and 1967, feeding 60 million people for two years.

Although the threat of outright famine has been more or less eliminated for the time being, human nutrition on the global scale is still in a sorry state. Malnutrition, particularly protein deficiency, exacts an enormous toll from the physical and mental development of the young in the poorer countries. The two billion people living in the poor countries consume an average of about 360 pounds of grain per year, or about a pound per day. With only one pound per day,

nearly all must be consumed directly to meet minimal energy requirements; little remains for feeding to livestock, which may convert only a tenth of their feed intake into meat or other edible human food. The average American, in contrast, consumes more than 1,600 pounds of grain per year. He eats only about 150 pounds of this directly in the form of bread, breakfast cereal and so on; the rest is consumed indirectly in the form of meat, milk and eggs. In short, he enjoys the luxury of the highly inefficient animal conversion of grain into tastier and somewhat more nutritious proteins. Thus the average North American currently makes about four times as great a demand on the earth's agricultural ecosystem as someone living in one of the poor countries.

As the income levels in these countries rise, so will their demand for a richer diet of animal products. For the increasing world population at the end of the century, which is expected to be twice the 3.5 billion of today, the world production of grain would have to be doubled merely to maintain present consumption levels. This increase, combined with the projected improvement in diet associated with gains in income over the next three decades, could nearly triple the demand for grain, requiring that the food supply increase more over the next three decades than it has in the 10,000 years since agriculture began.

There are ways in which this pressure can be eased somewhat. One is the breeding of higher protein content into grains and other crops, making them nutritionally more acceptable as alternatives to livestock products. Another is the development of vegetable substitutes for animal products, such as are already available in the form of oleo-margarine, soybean oil, imitation meats and other replacements. Pressures on the agricultural ecosystem would thus drive high-income man one step down in the food chain to a level of more efficient consumption of what could be produced by agriculture.

What is clearly needed today is a cooperative effort--more specifically, a world environmental agency--to monitor, investigate and regulate man's interventions in the environment, including those made in his quest for more food. Since many of his efforts to enlarge his food supply have a global impact, they can only be dealt with in the context of a global institution. The central question is no longer "Can we produce enough food?" but "What are the environmental consequences of attempting to do so?"

[Excerpted from "Human Food Production as a Process in the Biosphere," Scientific American. New York: Scientific American, Inc., Vol. 223, No. 3, September 1970, pp. 160-170. Copyright © 1970 by Scientific American, Inc. All Rights Reserved. To be reprinted in The Biosphere: San Francisco, W. H. Freeman and Co., in press.]



## Case Studies in Ecological Results of Development Activities

[A sample of development activities on three continents shows that unforeseen ecological consequences were often quite destructive in developing countries. In some cases recovery operations have been possible. Ecological considerations should be more carefully examined before development projects are undertaken.]

In December 1968 the Conservation Foundation, a Washington-based organization serving as a "bridge between ideas and action" in the field of conservation, and the Center for the Biology of Natural Systems, of Washington University in St. Louis, sponsored a three-day conference on the "Ecological Aspects of International Development." This meeting, held near Washington, is believed to represent the first ecological "post audit" of international development ever conducted.

The conference participants, numbering almost 70, were mainly scientists (mostly biologists) and social scientists from the United States and abroad. Russell Train, conference chairman and then president of the Conservation Foundation (now Chairman of the President's Council on Environmental Quality), told the conferees that the purpose of the meeting was to build a clear case for making ecological considerations central to development planning and decision-making. To do this, the conferees presented and discussed numerous case histories of development activities in developing countries which have either been destructive in themselves or have produced detrimental side effects, some of which environmental scientists could have predicted. Seven of these cases are summarized here.

### One. . . . . Irrigation Problems

When irrigation water is supplied without adequate drainage, the underground water table gradually rises, and may bring salts and other harmful minerals to the



surface. In the Punjab district of West Pakistan, for example, modern canal irrigation by 1949 had been extended to almost 40 million acres. By 1959 about 5 million acres had been seriously damaged by waterlogging or salinity and between 50,000 and 100,000 additional acres were being affected each year, many of them passing out of crop production altogether; by 1967 the affected area had reached 6.5 million acres.

In response to this situation, the government of West Pakistan has launched an ongoing program to complete some 9,000 tube wells by 1972 from which water can be pumped to the surface, lowering the water table. The key to the program, and the factor which differentiates it from its less effective predecessors, lies in the concentration of these tube wells in certain fields. By 1975 this government program may be extended to include some 20,000 wells and an area of 12 million acres. Combined with supplies from an even greater number of smaller privately-owned wells, and with the enhanced surface-water supplies made possible by the new Mangla and Tarbela dams on the Jhelum and Indus Rivers, the amount of water available for watercourse delivery in West Pakistan may reach 93.5 million acre-feet in 1975. This represents a net addition of about 38 percent to the 68 million acre-feet available in 1965.

But this increased water spread on the surface would serve only to increase the waterlogging and salinity damage were it not that the massive concentrations of high-capacity tube wells offer the hope of controlling the level of the water table. Wherever the groundwater is of usable quality (roughly, 2,000 parts per million of total dissolved solids or less, depending upon the chemical composition of the salts) its use for crops should produce a net gain and, through consumptive use and evapotranspiration, result in a gradual lowering of the water table. In other areas, saline groundwater will have to be mixed with surface water of good quality before being applied to crops. To accomplish this mixing, canal capacities in certain areas will have to be enlarged. In still other portions of the areas selected for initial development, the groundwater is too saline even for blending and will have to be exported, either via the rivers or via new wasteways constructed for the purpose.

Thus the groundwater and reclamation program underway in West Pakistan represents an extremely complex and costly effort to offset the consequences of surface-water irrigation. Under Pakistan's Third and Fourth Five-Year Plans (1965-75), the total cost of government-owned tube wells, canal remodeling, and drainage works (not including surface-water storage) will amount to \$1.1 billion. However, the gains achieved in West Pakistan's agricultural sector, which has been growing at a healthy rate of 3 to 4 percent per annum since 1960, should eventually more than compensate for these invest-

ments. These gains will depend not only on increased water supplies but on further inputs of fertilizers, improved seed varieties, etc.

In the Helmand Valley of Afghanistan, an ambitious program for the irrigation of arid lands began to encounter difficulties after less than ten years. By 1959, waterlogging and salinity had seriously affected most of the new project areas away from the flood plains, forcing the curtailment of planned expansion. During this same time, more than 60 percent of the irrigated land of Iraq had been seriously affected by salting. In the delta of the Nile, one quarter of the land is threatened by the high water table resulting from irrigation with inadequate farm drainage.

## Two. . . . . Aquatic Systems and Their Effect on the Epidemiology of Schistosomes

Schistosomiasis is a parasitic disease caused by trematodes or blood flukes. On a worldwide basis it is considered the second most prevalent parasitic disease in man and is getting worse. It is extremely debilitating, and occasionally fatal. Medical control or cure is proving very difficult, although many pharmaceutical firms have been working for some years to find a suitable drug.

The disease is acquired by humans through direct contact with infested water. Cercaria, one of the immature stages of the worm, bores directly through the skin and into the circulatory system of a person coming into contact with it. The worms grow in the liver and migrate to the blood vessels around the bladder and intestines where they mate and deposit their eggs. Through the feces of infected individuals the eggs may find their way to bodies of water where the eggs hatch into another immature form, the miracidia. This stage is taken in by the intermediate host, a snail, where the worms further develop into the cercariae which then emerge from the snail, enter the water again and infect man, completing the life cycle.

The worms, or schistosomes, have long existed but largely in regions that were sparsely populated, and the intermediate hosts of the parasite (snails) were scarce because of naturally unstable water conditions. Rapid economic and agricultural development has changed this picture in a number of areas. The construction of dams has stabilized waterflow, and resulted in fewer seasonal or flash floods in the streams and rivers. With more durable waterbodies there has been an increase in the extent of snail habitat. Where agricultural projects are based on irrigation, large populations live in close relationship with stable water systems; snails invade and breed, water contact and pollution increases, and this in turn produces a major upsurge in the prevalence of schistosomiasis and, what is probably more serious, an increase in the worm load per infected person.

There are two forms of the disease-causing worms. The more virulent one is Schistosoma mansoni and its intermediate host is the snail Biomphalaria pfeifferi. The other, less toxic, worm is Schistosoma haematobium whose intermediate host snail is Bulinus globosus. Where waterbodies are unstable and temporary, the mansoni form of schistosome parasite is rare because the snail host which carries it is less adaptable to these conditions. S. haematobium's host, on the other hand, is able to utilize these unstable conditions to better advantage. The more virulent S. mansoni is becoming more prevalent as water conditions are changed, while S. haematobium is spreading but at a slower rate.

With the rapid increase in population in central and southern Africa, development of agriculture will depend more and more on irrigation, especially in the more dry parts of the country where rainfall is unreliable. In the last four years almost as many cases of spinal complications due to S. mansoni have been reported in southern Africa alone as were reported for the whole globe up to 1963. In the Sudan, the Gezira irrigation project has brought a large increase in the disease. It is certain that this will occur on an even larger scale in the areas of Egypt newly irrigated by the Aswan dam.

### Three. . . . . Dams--Fishing

The Aswan Dam on the Nile River in Egypt is increasing the electrical power in that country and providing irrigation water for agriculture. It is also having some other effects. At one time the sardine fishing industry in the Eastern Mediterranean produced about 18,000 tons of sardines, worth roughly seven million dollars, each year. These fish constituted by weight about 48 percent of the total marine catch. Today this fishery has collapsed almost completely, having fallen to about 500 tons per year.

The drastic drop in the sardine catch has taken place since the construction of the Aswan Dam on the Nile at Sadd El Aali. Before the damming of the river, the Nile deposited great amounts of nutrients during its annual flood into the relatively infertile Mediterranean. The sediment carrying the nutrients was picked up by the river along its two thousand mile course from the mountains of Africa to the Mediterranean. The flood waters formed from annual rains and melting snow are now held up at the Aswan and released slowly; the sediment is blocked from reaching the mouth of the river, and the great schools of sardines which used to gather in the eastern Mediterranean are no longer there.

Another factor in the disappearance of the sardines from the Egyptian coast seems to be the loss of the period of decreased salinity. Each year during the flood season large amounts of fresh water

poured from the Nile into the Mediterranean. One of the species of sardines which used to be dominant in the area, Sardinus maderensis, timed its spawning to the period just prior to the flood each year. The species had adapted itself to these periods of lower salinity and apparently could not survive without them.

#### Four. . . . . Dams--Land Use

The dangers of instituting major hydrological projects without adequate ecological, social, and public health planning are illustrated by the Kariba Dam on the Zambezi River between Zambia and Rhodesia. Government officials did not make due allowance for the farming system and the cultural practices of the 29,000 Tonga people on the north bank of the Zambezi. Before the Kariba Dam, most of the people lived within a mile of the Zambezi river or its major tributaries. They planted crops twice a year primarily for local consumption. Cereals, legumes, and cucurbits were planted at the start of the rainy season in November in alluvial soil and harvested before the flood season in April. The second crop was planted after the flood water receded. Seed was sown just behind the retreating water from late April until September, then harvested before December.

The situation changed after the dam was constructed. The alluvial soil was flooded. From 1958 to 1963, even cultivation of the lakeshore margin was impossible because of rising water, and the Tonga had to depend on a single crop grown in the rainy season. The margin around man-made tropical lakes has potential for both dry and wet crops, particularly rice, but little research was available on the subject. The Tonga set about planting on their own in November, 1963, shortly after the high-water mark was reached. As a result of their initiative, one of the best maize crops ever was harvested in February and March, but that was not the case thereafter.

Before the dam, agricultural activities in the wet and dry seasons did not overlap. After the dam, the low-water period for dry season planting was August to December rather than April to November as before. This change interfered with ploughing in the rainy season. Even more exasperating to the Tonga farmers was the erratic rise and fall of the water-level, which was controlled to facilitate power-plant operations, not farming. In the 1964/65 season, the low point was reached in December, rather than in March as in the 1963/64 season. In the 1965/66 season, the level declined gradually for four months after the July peak, then plunged 10 feet in two months after November. But persons who planted the large area that became clear in December and January were deceived: the lake level reversed itself and rose rapidly during February and March, 1966. The high point that year was in July, three months after the usual peak before the dam. These fluctuations in the water-level destroyed the crops.

Agriculture downriver from the dam was hindered by even greater fluctuations.

Despite uncertainties which are greater under the conditions created by man than under natural conditions, the people will probably continue farming the margin of the river. The potential, however, in terms of agricultural production and job opportunities will be lost since the designers of the dam failed to accommodate regulation of water for power production to the needs of farmers.

#### Five. . . . . Laterization

In the humid tropics, high temperatures and heavy rainfall result in heavy leaching of the soil. Some tropical soils undergo a process called laterization, in which silica and other minerals are removed, leaving a red or yellow soil rich in iron oxide and alumina. When such soil is exposed and dried it is converted to a brick-like rock, laterite. According to some observers, notably Mary McNeil, human intervention in the tropics threatens to accelerate this process on a large scale. The attempt to establish an agricultural colony at Iata, Brazil, failed when deforestation and bulldozing resulted in laterization and the hardening of exposed fields to rock in less than five years. In West Africa, likewise, the removal of rain forest has in places led to rapid leaching and laterization of planned farmlands.

It has also been suggested that flood control and irrigation programs on the Mekong River might result in the acceleration of laterization. The Mekong Valley has managed, in spite of conditions strongly favoring laterization of the soil, to sustain productive agriculture. Each year the growing of crops depletes the already heavily-leached soil. However, the overflowing of the river system during the monsoon season floods the land and replenishes it with a new layer of silt. Retarding the annual floods might actually reduce, instead of improve, the food productivity of such areas.

#### Six. . . . . Insecticides

The Cañete Valley is a mountain valley in Peru with about 35,000 acres of agricultural land. At one time the valley was used for the growing of a number of varieties of vegetables as well as cotton. But in the last twenty years, because of its economic importance, cotton has become the dominant crop. Before 1949 the farmers of the valley had used simple inorganic compounds such as the arsenicals to control pests. But in 1949 various chlorinated hydrocarbons such as DDT, toxaphene, BHC and dieldrin imported from the United States were used to increase the yield of cotton. Before introduction of the new pesticides, between 1943 and 1949, the average yield of cotton was 442 pounds per acre of land. Immediately after the application of the organic pesticides the yield increased to 530 pounds per acre.



What was happening in the fields, however, was not a simple decrease in pests. There were seven species of insects that were damaging the cotton sufficiently to be considered pests when the spraying started. There were other species that were natural enemies of these cotton pests. There were also insects capable of becoming pests but kept under control by their own natural enemies. The spraying destroyed insects in all these categories. After the spraying, the fields were invaded from the surrounding area, not only by the original seven pest species, but by six additional pest species. The sprayed fields had lost the protection of all the natural enemies of the cotton pests.

Another factor soon entered the picture as pesticide-resistant strains of the insects began to emerge. By late 1952 BHC was no longer effective against aphids. By 1957 toxaphene failed to control the leafworm *Anomis*. In 1955/56 the boll weevil reached high levels of concentration despite heavy pesticide treatment. Next the Peruvian bollworm began heavily infesting the cotton and showed a high degree of resistance to DDT. Seven years after the initial use of synthetic organic pesticides the total crop loss reached 50 percent and the harvest dropped to 264 pounds per acre. At the same time there was the ever increasing cost of heavier and more frequent pesticide applications.

The drop in yields meant impending economic disaster for the valley, and growers formed an organization aided by government support to impose strict controls on the use of pesticides in an effort to reverse the trend. The use of synthetic organic pesticides was forbidden without special permit. There was a return to the use of mineral insecticides, lead and calcium arsenate and nicotine sulfate. These insecticides are not contact poisons like the synthetics; they must be eaten by the pests in order to be effective. They did not kill as many individual insects, but in the long run, this proved to be a boon: the natural enemies of the cotton pests were not likely to eat the mineral insecticides, and therefore were not wiped out. Also, resistant strains did not develop as a result of the lesser killing action of the mineral insecticides. The few insects that survive treatment of a field with a contact poison (like the synthetic insecticides) are likely to be those that are resistant to it. The next generation will be bred from these resistant parents. But if a variety of individual insects escape--as they do when the mineral pesticides are used--there is no selection for a particular, resistant strain.

The mineral pesticides killed only enough insects to bring the pest population down to a level where natural predators and parasites could keep them in check. To aid the natural or biological control of pests the government began the importation of parasites and predators. An agricultural experimentation station was established and



equipped for the breeding of parasitic wasps. As an additional measure, the government prohibited the growth of cotton on marginal lands. Since these measures were instituted, only occasional spraying to control severe pest outbreaks has been needed.

#### Seven. . . . . Rodenticides

Among the innovations introduced in Israel's efforts to modernize agriculture was widespread use of thallium sulphate-coated wheat aimed at control of three species of mouse pests. In 1962 it was reported: "Continued poisoning operations have not had the desired effects upon the mice. In fact the opposite has been the case." According to the report, the destruction of biological controls upon the mouse population resulted from secondary poisoning effects of thallium. Birds of prey which habitually feed on mice were nearly eliminated. Within ten years some species, like the black kite, the long-legged buzzard, the Egyptian vulture and eagles of the clangapomarian group, were reduced to less than 10 percent of their original population density. (Birds of prey which do not habitually feed on mice, like the Bonelli's eagles and the Serpent's eagle, were not influenced by the secondary thallium poisoning and have been able to maintain their original population density throughout these years.) With normal biological controls removed, nothing was left to check the mouse population. Poisoning, therefore, has had to be undertaken almost continuously resulting in a considerable waste in both material and labor. It is now planned to make experiments with rodenticides (anti-coagulants in the first line) which may not cause secondary poisoning.

[Adapted from several summary reports on the Conference prepared by the Conservation Foundation. Proceedings of the Conference will be published as The Careless Technology: Ecology and International Development, M. Taghi Farvar and John P. Milton, editors, New York, Natural History Press, Doubleday, 1971.]

Right: Smoke from sugar factory, Colombia. [Photo: World Health Organization (WHO).]

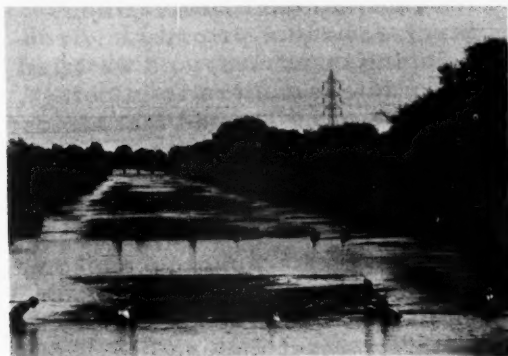


Below: Erosion made town uninhabitable, Turkey.



Above: Surface salt from waterlogging, India.

Below: Anti-erosion project, Turkey.



Above: Aquatic weeds in irrigation canal, India.

Right: People exposed to schistosomiasis, Egypt.

[Photos: All above, FAO; right, WHO.]



## Identifying Environmental Options in Development

Bill L. Long

[The following was excerpted from a talk given to the Society for International Development, Washington, D. C. Chapter, 14 October 1970.]

The basic issue confronting us, I believe, is how countries can be motivated to build environmental safeguards into their development activities. Early in 1970 the U.S. Agency for International Development (AID) conducted a summary survey of priority environmental problems in developing countries, and we tried to assess what host country interest there is in doing something about these. The survey showed that almost every country has environmental problems of one type or another. In terms of frequency, overgrazing and the attendant effects of erosion and siltation of irrigation canals and reservoirs were mentioned by over half of the countries we queried. As would be expected, air pollution is a serious problem in most of the countries with urbanized localities. Other problems are buildup of DDT and uncertainty about the use of chemical pesticides, the building of dams followed by an upsurge in schistosomiasis, and the growth of aquatic weeds due to runoff from farm lands or the introduction of other nutrients. We also found that there is an awareness of these problems and some idea of their magnitude.

However, the attitudes on the part of the host countries varied considerably. Some countries are already taking action--the Philippines for instance, where their Congress passed a resolution recently that is somewhat akin to our own Environmental Quality Act. On the

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other hand we have a number of visitors coming through from Africa and elsewhere, and when we try to speak to them about environmental problems they say, these problems are the rich man's disease. Right now we are faced with malaria, they say, and we need DDT; our people are poor, we need new industry; and while we recognize that there are going to be some severe ecological consequences we must push ahead to try to better our standard of living. In other instances, countries feel that the environmental considerations are a smoke-screen to keep them from competing in world markets.

In view of these diverse attitudes, I think that the answer for environmental protection lies in our being able to identify options to the developing countries which will allow them to achieve their development goals while minimizing environmental degradation. It must be understood, for example, that whenever a dam is built it will have some kind of environmental impact: if you build in location A you will get one set of results; at location B, another set of results; at location C, still another. We must therefore be prepared to propose safer but effective alternative sites for a proposal we judge to be ecologically unsound, identifying for each possibility the consequences for the environment along with the differences in productivity and cost. It should be recognized that when one selects an option that provides a greater environmental safeguard, it will probably be more expensive (or less efficient), and someone must stand ready to bear the added cost.

At this time we are less well prepared than we should be to identify options in most cases. Too many scientists are just looking at projects that already have been built and telling us why they are harmful; or they engage in pre-development surveys and tell us that the water temperature is going to go up or excessive nutrients are going to be introduced, and therefore a dam should not be constructed. We will have to go a step further than that, and the scientists are going to have to help us with the hard decisions. Given that more electricity is needed, where do we build the dam or how else do we generate it? Not just: "Don't build the dam." The classic example is the Aswan Dam on the Nile: you build a great dam and you end up with schistosomiasis occurring along the banks with incidence up to 50 percent, changing the flow of nutrients and fresh water and damaging your commercial fisheries, etc. This is the example so often used by ecologists to point out how environmental considerations were not taken into account. But I would submit that, given this knowledge before the dam was ever built, and weighing it against the fact that it will bring millions of acres under irrigation and provide electricity for new industry, the government would nevertheless go ahead with building the same dam today.

As we move on toward the end of this century we are going to see dams springing up in Africa and Latin America on almost every major

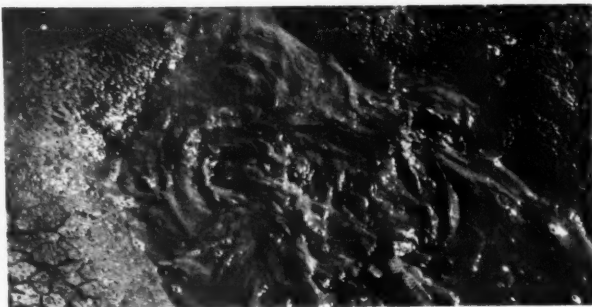
river, duplicating the environmental problems of the past if no reasonable alternatives are available. Future ecological "mistakes" will be, in truth, ecological "sacrifices." Consequently, if we desire to protect the environment, we must be prepared to identify how development can proceed safely, rather than to argue why it shouldn't proceed. To implement proposed solutions, we are going to have to develop low-cost pollution control technologies that one can afford to build into some of the development activities we might wish to support abroad.

Kariba Dam, Zambia-Rhodesia. [Photo: World Bank]



Snails that harbor schistosomes. [Photo: WHO, D. Henrioud.]

Fish trapped in silt. [Photo: USDA/Soil Conservation Service.]



## The Human Environment and International Cooperation

Thomas F. Malone and  
Henry J. Kellermann

[The problems of environment have recently elicited a wide and growing concern, and a new rationale is evolving at the international level for meeting these problems. The 1972 United Nations Conference on Human Environment will require a careful selection of priorities and an action-oriented study of problems.]

World population is growing at a rate that averages somewhere between two and three percent per year. Productivity, or the output of goods and services per hour of human labor, is growing at another two or three percent annually. These numbers, taken together, suggest that we are in the process of placing potentially infinite burdens on our earth environment which is unquestionably finite in its capacity. Man's expanding mastery of matter and energy and his deeper understanding of the processes that govern plant and animal life, coupled with a rapidly growing utilization of the information processing capabilities, have brought within reach "the good life" for all. However, the improvident manner in which we are proceeding in interacting with our natural and our man-made environment presents us with the very real prospect that we may be in the process of degrading--rather than enhancing or even preserving--the quality of human life.

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It is only in recent years that more than a handful of people concerned themselves with this problem. Today the growing threat of pollution and the depletion of resources have reached a stage at which more and more voices are being raised in alarm and indignation. While the fearful prospects are often couched in extreme terms, and while the strongest concern has so far been concentrated in industrialized countries, these warning signals seem to be a necessary concomitant to a developing world awareness that the problem of the human environment is becoming critical, that present efforts to deal with it seriously and intelligently may not be commensurate with its magnitude and complexity, and that nothing short of marshalling the best thinking and a substantial worldwide effort may be adequate to bring the problem under control. In addition, it is generally agreed that such an effort must be undertaken by nations acting in concert, because it serves the self-interest of each.

It was considerations of this kind that prompted the Twenty-third General Assembly of the United Nations to adopt a resolution to convene in June 1972 in Sweden a United Nations Conference on Human Environment which inter alia should have as its main purpose:

... to provide a framework for comprehensive consideration within the United Nations of the problems of the human environment in order to focus the attention of governments and public opinion on the importance and urgency of this question and also to identify those aspects of it that can only or best be solved through international cooperation and agreement.

#### New Rationale

Pollution of air, water and soil have been for many years the concern of national governments and international agencies, such as the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) and many others, some of which have done a yeoman job in dealing with problems within their spheres of competence. WHO has worked for some years on measurements of air, water, and soil pollution. In 1967 it established an International Reference Center for Air Pollution, and in 1968 the International Reference Center on Waste Disposal and Community Water Supply. Since 1946, FAO has concentrated its activities on problems of soil conservation and on the institutional and legal aspects of the management of land. It has also promoted pest control measures. Since 1954, the International Maritime Consultative Organization (IMCO) has acted as the depository of the International Convention for the Prevention of Pollution of the Sea by Oil. The World Meteorological Organization (WMO) has given major attention to the establishment of a World Weather Watch. The International Atomic Energy Agency (IAEA) has been responsible for programs on all aspects of radioactive pollution caused by the peaceful uses of atomic energy and

has issued basic safety standards. The examples could be expanded, but the above list may suffice to indicate the variety and range of activities sponsored and performed by inter-governmental agencies during the last 20-25 years, each of which could be roughly classified as environmental.

The true significance of the UN resolution lies in the fact that it does not simply add another set of proposals to those already on record, but that it provides a completely new departure for an international approach to environmental problems.

Here are the truly innovative features of Resolution 2398 (XXIII):

1. by addressing itself to problems of the whole environment rather than of air, water or soil, it not only provides a synoptic view of the total range and complexity of the numerous problems created by man's interaction with his surroundings, but, more importantly, emphasizes the cumulative effect of his actions and, above all, the functional interdependence of nature's processes, cycles and resources;
2. by introducing the "human" element, it exposes and defines the situation as a social as well as a technological problem;
3. by thus identifying the problem as a man-made attack upon nature and upon himself, it calls for an interdisciplinary approach by natural and social scientists, to wit, a reexamination of the physical and technological as well as the economic, social, cultural and moral causes;
4. by presenting the various manifestations of the problem as parts of a worldwide phenomenon threatening nations and peoples everywhere it has raised the problem to the dimension of a global crisis;
5. by insisting on the need and feasibility of an intergovernmental plan of action on all appropriate levels of responsibility, it proposes a new departure in international crisis management; and finally
6. by emphasizing the ubiquitous, non-partisan character of the problem, it opens new vistas for international cooperation, involving countries regardless of their political, social or ideological complexion or their state of economic development.

In January 1969 the Secretary General of the United Nations invited member governments, specialized agencies, and other appropriate organizations of the UN system to provide him with their views on a report which he had been requested to prepare in compliance

with the UN resolution [see pp. 5-11 above]. This report recognized the universality of the problem, the function of the environment as a public resource, the responsibility of public authorities and citizens, and the need for effective and rational management. Above all, it identified the primary purpose of the Conference as that of action (as against a scientific conference), i. e., it was "conceived as an important means of stimulating and providing guidelines for action by national governments and international organizations."

The preparation of the agenda and the organization of the Conference were assigned in early 1970 to a Preparatory Committee of 27 member states assisted by a secretariat. The Committee has divided the subject matter into three areas: 1) environmental aspects of human settlements; 2) rational management of natural resources; and 3) environmental pollution. Recently Maurice Strong, President of the International Development Agency of Canada, was appointed Secretary General of the Stockholm Conference with the rank of UN Undersecretary General.

#### Development vs. Environment

Early in its deliberations the Preparatory Committee faced up to a problem which, unless realistically assessed and confronted, may prove a major hurdle to agreement at the Conference: the relationship between economic growth and environmental quality. There have been some warning signals from developing countries that environmental restraints must not be allowed to interfere with national development. Countries now in the pre-industrialized stage find it difficult to comprehend and even less to share the concern of nations plagued by the ecological fallout of technology, industrialization and urbanization. Rather than seeing parts of funds, now earmarked for aid or capital investment, diverted for purposes of environmental management, some of these countries appear satisfied to accept pollution as the inevitable by-product and proof of vigorous and successful development. The new preoccupation with the environment by the "have" nations is even suspected by some as a pretext of donors to cut back development assistance or, worse yet, to forestall undesired economic competition.

The Preparatory Committee found it desirable to emphasize that: "The management of the environment must not retard the development process or the maximum rational use of natural resources. Continuing economic progress must be ensured while minimizing environmental degradation and pollution." The need for "new economic thinking, new legal instruments, new administrative resources and new governmental priorities was generally recognized by the Committee."

The problem is a critical one. Assurances by the industrialized world that economic development will not be deflected or reduced by ecological safeguards may not suffice; nor will the argument of the indivisibility of the environment be necessarily convincing to countries that have not yet suffered the costly diseconomies of national growth or the drift of pollutants across their frontiers. Everything now depends on whether the industrialized nations of the UN can furnish conclusive proof that environmental management, far from being a handicap, is actually a controlling factor in any sound development program and essential to its success.

Conceivably the prospect of a "North-South" confrontation between developed and developing countries over the alleged antithesis between economic development and ecological quality was one of the factors which forced the Preparatory Committee to conclude that: "while there remain many technological operations to be solved, problems of the human environment (are) increasingly of a socio-economic nature." The socio-economic factor has indeed emerged as one of the most stubborn and probably most difficult features of the environmental problem, and it takes a variety of forms.

#### Growth of International Initiatives

The Economic Commission for Europe (ECE) is now preparing a Conference on Problems Relating to the Environment to be held at Prague in the spring of 1971; its objectives are to help governments determine their environmental policies, particularly those of an economic nature. In the Council of Europe which held its European Conservation Conference in February 1970, key spokesmen called for "a new attitude to meet this frenzy of economic development." The American delegation drew attention to the importance of international agreement among governments and industries to achieve some equitable distribution of anti-pollution costs. Industries in certain countries which are prepared to clean up their production process at considerable cost to themselves and to their buyers, are reluctant to do so for fear of pricing themselves out of the world market. A different type of resistance can be expected from countries and industries that would be severely affected by the prohibition or reduction of export of sulphur-containing oil, DDT and other "hard" pesticides.

The initiatives now going forward on the global inter-governmental plane have spread to the regional level. Every one of the UN's regional commissions, along with the Organization for Economic Cooperation and Development (OECD) and the North Atlantic Treaty Organization (NATO), are engaged in a series of environmental programs. This proliferation of international initiatives reflects the escalation of world interest, but it is also creating a major problem for governments which are compelled to keep a substantial

number of experts continuously on the move from one conference to the next. The situation is compounded by bureaucratic rivalries among various international organizations which have vested but often conflicting interests in one or more aspects of the environment and are reluctant to surrender their stake.

The International Council of Scientific Unions (ICSU) was among the first non-governmental organizations to respond to the appeal of UNESCO's Biosphere Conference for the creation of "an international and interdisciplinary program on the rational utilization and conservation of the resources of the biosphere..." The decision of ICSU's Executive Committee to create a Scientific Committee on the Problems of the Environment (SCOPE) manifested the growing interest on the part of the international science community to play an active role in world environmental programs. The first meeting of SCOPE in September, 1970 reaffirmed its mandate as "a non-governmental interdisciplinary and international council of scientists and a non-governmental resource for the benefit of governments and non-governmental agencies with respect to environmental problems."

#### Structure vs. Substance

A question more serious than the plethora of competitive efforts is the need for new substantive competence in international agencies now entering the field. The United Nations, which is now engaged in the preparation of its ambitious Conference, has had no permanent staff or structure dealing exclusively with the total complex of environmental problems. It has delegated parts of the job to some of its constituent organs, commissions, committees and specialized agencies and none of them can claim more than technical competency in special fields. The problems addressed by the Conference, on the other hand, are global and call for a synthesis rather than for technical analysis of individual phenomena. Moreover, the very complexity of the problem and the almost limitless variety of its manifestations call for careful identification and selection of priorities in advance of the Conference. Finally, since the Conference is not conceived as a huge gathering of scientists for detailed discussion of special problems but as a meeting of policymakers with the focus on action, it is imperative that problems suited for action be carefully sorted out in advance by experts and be submitted to the conferees in the form of specific recommendations.

[Excerpted from "The Human Environment and International Cooperation," Science magazine (Washington, D. C.), in Preparation. Copyright © 1970 by the American Association for the Advancement of Science.]



Traditional Values and  
the Development Process

By [illegible]

[Faded text, likely the beginning of an article or introduction, discussing traditional values and development.]



# TRADITION AND MODERNIZATION



CAMELS AND CEMENT PLANT, IRAN  
[PHOTO: U. S. AGENCY FOR  
INTERNATIONAL DEVELOPMENT]

## Traditional Values and the Development Process

Soedjatmoko

[For Asian political leaders (such as the author) involved in the development process of their own countries, key problems for which social sciences cannot yet supply answers involve questions of how to motivate and manage volatile processes of social change. Religions, incorporating traditional values but encompassing developmental needs, can play an important role in transitions toward modernization, and may also help shape its goals.]

The prevalent theories of economic development start off by identifying factors that affect the growth rate of the net domestic product, savings and investment rates and trade levels. While useful in increasing our understanding of economic development, these theories and models say nothing about how to get development going. They deal with the externals of the development process, and its measurable symptoms. The compulsion towards increasing refinement of measurements, and the craving for theoretical elegance and symmetry further add to the irrelevance of these models for those of us who, while deeply involved in the development process itself, are not economists. A number of theories of political development have also been formulated. But most of these theoretical models seem to be based on a very limited number of variables and unilinear explanations operating within a single system. The factors that can be identified and measured in their impact on the growth rate under specified assumptions, for instance, may turn out to have only very limited relevance in a rapidly changing society. It is significant that there are few theories which try to relate economic growth with the process of political development.

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We still do not know how exactly the development process can be set into motion, and even less at what point growth can become a self-sustaining process. And while our understanding of the development process has greatly increased as a result of the empirical and theoretical work that has been done, those that have a stake in the development of their nation are very acutely aware of the lack of operational guidelines which might help them in their efforts to overcome the sluggishness or stagnation of their societies.

Reasons for the shortcomings of these theories may be, first, that they seem to remove the problems of development away from the reality of power and politics and in this way seem to reduce the decisions that have to be taken to simple technocratic and bureaucratic ones. But we know how intensely political the simple choice of the site for a dam or a factory in our own community can be, or the choice between a weapons system and a road and harbor system. Also, social change and development is bound to have political implications which will have a bearing on the distribution of power. Likewise, the degree of power a government is able to exert significantly influences the range of economic policy options open to it.

Secondly, they overlook the importance of the cognitive factors in development and growth. It is man's vision of the future, his hopes, fears and expectations that determine his actions in the present; his awareness of the past influences him as well. It is impossible to understand the dynamics of a social system responding to new problems and challenges--and this is what development is all about--unless one also has an understanding of these hopes and aspirations as well as of the self image of the people within that system. And until we take into account how man in a given society perceives his own problems, his interests and his goals, we really have no clue as to how and why he will react in a particular way and not in another.

Thirdly, economic development cannot be understood in isolation; it is part of a more general process of social transformation. We are not simply concerned with the attainment of economic goals; we are dealing with major changes in a society, with the building of a new nation, with painful processes of disintegration and reintegration at various levels of society. Nation building has its own requirements: decolonization has left a number of Asian nations with a heritage of unresolved conflicts, resulting from or aggravated by the arbitrariness with which colonial boundaries had been drawn, the preferential treatment accorded certain ethnic or communal groups, the existence of unintegrated minorities. National independence requires the welding of these often quite disparate elements into a single polity capable of coping with the requirements of the 20th century. The goals and priorities, the phasing of economic development as well as the feasibility of specific economic policies inevitably are deeply affected by these overall nation building requirements.

Fourthly, a one-dimensionality is characteristic of these development models. It is important to realize that in nation building and development we are not dealing with unilinear processes of gradual and rational adjustment and redirection, but with discontinuities, with strains and stresses, conflict and disorder. It is important, too, to be sensitive to the possibility of failure or even collapse, to the risks and the dangers in any process of social transformation. We should also be aware of the depth of human emotions, of the hope and fervor, the fear and despair which are involved, of the terrible violence and cruelty of which man is capable in extreme situations. At the same time we cannot forget the immense magnitude and frightening urgency of the problems which threaten most Asian developing societies. The pressure of population increase on resources, the massive and rapidly growing unemployment problem, urbanization and increasingly inadequate educational systems--all of these problems make a rapid rate of development an essential pre-condition for the viability of many new Asian states irrespective of their politico-economic system.

#### Political Requirements

Unless a government has a strong commitment to economic development, no sustained development is possible. Such a commitment implies the will to avoid war and to avoid expenditures that only satisfy the craving for grandeur and splendor. It also means the political courage to bring about administrative reform and the forging of national discipline necessary for the effectiveness of any development policies. That courage--as well as a sufficient power base--will also be necessary to implement the unpopular measures that may be crucial to the success of the development process.

Above all such a commitment means the willingness and the capability to reorganize the whole nation for development, not only economically but also politically. In many cases this involves major structural changes. Tax reform, for example, may increase the government's capacity to mobilize domestic resources; land reform may lead to higher levels of production. Both are a means to release new developmental impulses in the society at large, but they are also profoundly disturbing and politically hazardous. Economic growth can up to a point take place without radically disruptive changes in the social system, but it would be an illusion to think that the point of self-sustaining development could be reached without any structural economic and political change. We should also realize that structural change is not only a condition for development, but will also arise as a result of economic development. Both such structural changes inevitably bring in their wake shifts in the distribution of power. The "green revolution" for instance is bound to lead to changes in the balance of power in every village, with likely repercussions on regional and national balances of forces. Likewise, rapid social change signi-

ificantly aggravates the customary intergenerational conflict; the emergence of a new generation then becomes a serious challenge to the prevailing system.

The capacity of a government committed to economic development to stay the course and to maintain its momentum will also depend on the courage and wisdom it has to absorb the political consequences of development, and to accept some degree of damage to its own power base. It must show the skills to appeal to the new elements of power that will emerge in the successive phases of development. Development continually creates new constituencies which will require recruitment and integration into a shifting power base, and the political risks to any existing government are obvious. The political system which made development possible may as a result itself change. Development, thus, does not immediately lead to political stability, but is inevitably accompanied by some measure of instability which the political system must develop the capacity to absorb.

While we have spoken of the need for strong initial power and support as a launching pad for development, at the same time, history has shown the limits of governmental power in most developing societies. Regardless of whether such power is structured at the center as a democracy or an autocracy, the low level of managerial effectiveness and the generally inefficient bureaucracy put very distinct limits on the implementation of development policies by government fiat. Unless government leadership succeeds in setting in motion widening areas of auto-activity geared to development within the social system as a whole, there is very little hope that development plans can take on life and reality. Change from above is insufficient; but the importance of continuously broadening popular participation is too often overlooked. The capability of establishing and developing voluntary associations for new development-oriented purposes--such as small business groupings, trade unions, cooperatives, credit unions, and community service organizations--is just as important as the organizational and managerial capabilities of the government. These networks of voluntary associations constitute the new emancipating forces, the instrumentalities capable of harnessing impulses for change and progress, making possible the growth of an increasingly open society.

#### Requirements of Social Change

The forward movement of a whole social system obviously depends on a broad consensus regarding goals and means--some shared vision of the future capable of arousing new hope. Unless realities can be seen with new eyes, however, and hope translated into a sense of new profitable opportunities on the individual level, such vision as I am talking about will have little motivating value. At the same time the

history of new independent nations has made it clear that unless the new goals are related to prevailing notions, attitudes and values, it is almost impossible to mobilize broad sectors of our transitional societies.

The social organization in most traditional Asian societies was shaped by religion. The most meaningful language of large parts of Asia's masses is still the language of religion. In order to comprehend their social dynamics, and develop ways of utilizing or circumventing them in the development process, we need to understand how religion meshes into social relations and into collective as well as individual human behavior. These religions can be a strong motivating and integrative force. They can also be an obstacle to necessary change. Most religions have at one point or another in history played one of these roles and usually both--at different times--and it would be folly to ignore the potential that religions have to facilitate or to hamper the process of development and nation building.

There are other motivating forces that can play a role in the development process. One of them is self-confidence and pride. Success in the attainment of particular intermediate goals in trade, in industry, in politics may have a spillover effect on other sectors of society, stimulating them to greater efforts and generating a climate of renewed hope and heightened activity. Fear and the danger to national survival may spur a society to greater exertion and the fullest use of its capabilities. Class hatred, fuelled by deliberate class struggle and welded into an instrument of power, may be the trigger; but so also can the simple desire for freedom and justice and the yearning for a better life. It is the task of any developmental ideology--secular or religious--to relate the elements of hope, the capacity to look at the difficulties of one's situation in the light of new opportunities, and man's basic yearnings--for better material conditions, for education, for justice, equality, participatory responsibility as well as for spiritual development--into a consistent structure of thought and perspective.

Models, rational strategies for development, utopian blueprints are not enough. What is needed is a vision that is at the same time a road map towards its realization as well as a method for the struggle towards its attainment. But there is no general strategy for development. Each nation will have to develop its own vision of the future out of the materials of its own history, its own problems, its own national make-up. Western models of modernization have dominated much of the thinking on development, but the existence of such non-Western models as the Russian and the Japanese is convincing evidence of the historical freedom that--within limits--each nation has in shaping its own future. It may eventually turn out that adherence to the Western model is not the rule, but the exception.



## Values, Religions, and the Hazards to Development

The development process has no built-in guarantee against failure or derailment, nor does it have a built-in mechanism for the maintenance of its momentum. While we speak in terms of new goals, new purposes and values we should not close our eyes to the pains of social transformation. Rapid social change is inevitably accompanied by growing uncertainties, disorientation, deep anxieties and fear, leading towards increasing resistance to change. The capacity of a culture to resist change is perhaps as important to the health of that culture as is its capacity to innovate and to absorb change, for without such resistance there would be neither structure nor continuity. However, the anxieties and fears in the wake of development tend to stiffen resistance to change, and especially when these fears are played upon for political reasons, new and dangerous rigidities may develop within the system. Not only institutions and vested interests but also cherished values are threatened. Thus in cultures where the family is the most important social unit in society, and where family loyalty and solidarity are virtues of the highest order, the growth of an effective feeling of a higher loyalty to the nation, essential to the solidification of the new nation, may be difficult to bring to life. The persistence of "corruption" in some countries often reflects the incompleteness of this transition to the more impersonal requirements of the modern nation state.

Most serious are the problems which arise from the increasing irrelevance of traditional conceptions of social reality, and the consequent persistence of narrow political preoccupations and conflict patterns which bear no relation whatsoever to the new and urgent problems. In a sense the inability of many to perceive the new dimensions reflects the inner fragmentation and identity crises through which social transformation is taking them. The establishment of a new, creative relationship to social reality, as well as the reformulation of a new system of commitments, pivots around the development of a new sense of identity, on the collective and on the personal level. The kind of person I want to be, the kind of relations I want to have with my fellow man, the kind of society and the kind of world I want to live in are the central questions in the search for this identity and in the process of nation building.

It is, of course, possible to look for answers to these questions from the perspective which the humanities and the social sciences provide. But on the whole their positivism and operational pragmatism fail to meet the intensely felt human needs in these situations. Some secular ideologies, to be sure, have shown they can have such integrative and motivational power. However, it would be a serious mistake to overlook the transcendental and essentially religious di-

mensions to these questions. Few people and very few cultures in Asia are able to live among the happenings of our day-to-day life without some sense of their larger meaning. Man's mortality, the cycle of birth and death, growth and decay, the seeming senselessness of much of human experience only becomes bearable within the context of some kind of awareness of eternal truth and reality. And especially in Asia, where religions have not only been roads to the salvation of the individual soul but also have helped shape systems of social organizations, this aspect should be taken into account in any analysis of social dynamics.

As claimants to ultimate truth and reality, all religions have always had difficulty in their relationship to history and social change. Rapid social change aggravates this already difficult relationship. It leads to a sharp increase in the mutations in morality and of human conduct that run counter to the standards of behavior which have, over time, grown up around religion. This in turn may strengthen the inclination to perceive the nature of the problems created by social change as simple moral problems, which makes it even more difficult for the religion concerned to relate creatively to change. Bewilderment, frustration and despair therefore often turn towards a more fundamentalist and rigidly traditionalist position, or on the other extreme, to religious and even secular utopianism or total secularization. Explosive social tensions can become almost unavoidable.

If, however, the prevailing religion in a changing society develops, through its leaders, an adequate comprehension of the process of social change, of the urgency of development, of the social factors impelling it and the requirements for civility and for the viability of any political system, it can play an important reintegrative role. Because religion, even more than a secular ideology, is a total system of integration, it contains within itself the authority and directive capacity for reordering men's values and goals.

The attainment of, or failure to attain, the goals of development could very much be determined by whether the religions of Asia will be able to absorb and digest the new elements and perspectives that come with social change, without loss of their own integrity. Insofar as this comes about, they will be able to play the essentially reintegrative and motivating role described here. Further, the manner in which the religions of Asia position themselves relative to the development process is bound to have a profound impact on the political process and systems that will emerge. In other words, unless the religions in Asia are capable of formulating their own development ideology, and learn to use their tremendous influence on the masses toward the attainment of development goals, they may in the end be shunted aside, and it may well be the secular counter-religions which will shape the political systems through which these goals will be achieved.

Pluralism. So far we have assumed a homogeneous society. The relationship between religion and the development process becomes even more complicated where nations are composed of different cultures and different religions. In those societies modus vivendi have emerged which made peaceful coexistence possible, and in a static condition these unarticulated inter-religious balances could function relatively well. However, religions and their practitioners do have different capacities to absorb social change and to adjust to modernization. In some cases extraneous or incidental factors in the development process may seem to work to the advantage of one religion as against another. The development process, therefore, may at some point upset the delicate inter-religious balances that had been worked out and on which religious tolerance had been built. This is bound to resuscitate the fears and suspicions of the various religious groups about each other. In such a climate the problems of change may be perceived in terms of religious conflict. Violence attendant to the breakdown of systems of inter-religious accommodation has occurred in a number of our countries.

It is therefore of the greatest importance for the viability of the political system in a religiously pluralistic developing nation that no single religion become totally identified with one or other specific aspect, or with the whole of the development effort, to the exclusion of the others. There is, of course, room for healthy competition in modernization among the religions where such competition serves to accelerate change and increases the capacity of the social system for creative adjustment to the requirements of modern life. But we should be aware of the point where such competition becomes counter-productive.

An involvement of all religions in a country and their organizations will be an important step towards the building of a transcommunal consensus for development, and in this way contribute to the decommunalization of development. All religions in a society thus have a common interest in developing among themselves the understanding, accommodations and self-restraints, as well as modes of cooperation, which will ensure the continued participation of all other religions in development efforts. They also have a common stake in strengthening the capacity of the nation to deal with conflicts peacefully, with full regard for basic human rights. While many of our nations are committed to these basic rights, the social pre-conditions for their effective application are on the whole quite fragile. Strengthening the "rules of the game" for conflict resolution in our relatively new nation states is therefore a conditio sine qua non for maintaining the political consensus and social cohesiveness on which our national existence depends. It is impossible to exaggerate the need for such an effort.

In the history of many parts of Asia millenarian movements have been familiar features. The persistent expectations in one form or

another of the "Just King" suddenly appearing to lead the establishment of a just and prosperous society, and the innumerable violent outbreaks of peasant rebellions not leading to any appreciable change in the social structure, are symptomatic of this outlook. Instant utopianism, especially if coupled with violence, may revive archaic and regressive patterns of thought and behavior which will seriously set back the struggle for emancipation, modernization and development. As one whose life was shaped by revolution and the violence that goes with it, I would be the last person to deny the role violence can play, under certain conditions, in the shaping of new societies. But historical experience also shows how--after independence--the application of violence in a pluralistic society can lead to the total breakdown of traditional mechanisms for intercommunal accommodation, leading to unimaginable waves of bloodshed. That the new utopianism in some of our countries is not peasant-based but urban-centered, operating among religiously or morally motivated sons of the middle class, should not prevent us from drawing the lessons from these phenomena.

#### Involvement of Religions in Development

My argument points to the desirability, even the necessity, of religions being involved in the process, and in many countries in the politics of development, at least in some specific ways. Political involvement of religious institutions in whatever form, however, raises some fundamental questions. How can a religion immerse itself in the political process without losing its soul?

The essence of religion escapes us if it is discussed merely in terms of something else rather than in its own terms. This leads us to a consideration of religion in its relationship to the goals of development. Because religion is essentially concerned with the ultimate questions regarding the meaning and the purpose of life, it cannot unquestioningly abide by the conventional wisdom of the economists, the sociologists or the political scientists and the goals they implicitly assume for the development process. In facing up to the need for economic development, all religions must raise the question of goals as well as of means. Should development aim at duplicating--with minor modifications at best--the American, the Russian or the Japanese model of development and the goals implicit in them? Do not the cultural crises in which the industrial and technologically advanced nations find themselves--whatever their ideology--their spiritual malaise and their high ecological cost raise the question whether Asian development should not search for different directions, based on a different balance between man and nature, man and society, man and technology and man and the supernatural? Should not the religions in Asia raise the question of the desirability and possibility of alternative social systems capable of coping with the problems of

the 20th and 21st centuries, that could be maintained at a lower human and ecological cost?

The religions of Asia cannot escape the responsibility, while playing out their constructive role in the development process, of raising these fundamental issues so that each choice in the course of development is made in full awareness of the options that are available once man refuses to follow unquestioningly the steps already taken by the industrially advanced nations. In order to play this creative role it will be necessary for religious leaders to speak in terms that make sense to their followers in their efforts towards material, intellectual and spiritual improvement. While it is not the task of religion to provide specific solutions to the problems it raises, by raising these questions each step of the way, and insisting on their being confronted, it may possibly improve the quality of what we--as human beings--are making of ourselves in the pursuit of these goals.

[Excerpted from "Religions and the Development Process in Asia," a speech presented to the Asian Ecumenical Conference for Development, Tokyo, Japan, 15 July 1970.]

## Modernization and Social Structure in Jamshedpur

Michael M. Ames

[People living in Jamshedpur belong both to the modernized world of industry and the traditional world. They maintain a pluralistic or relativistic ethical system: "class for the city and caste for the village." The flexibility which the joint family system shows may facilitate more than obstruct the adjustment of people to the demands of industrialization.]

Jamshedpur in Bihar State west of Calcutta is the oldest steel city in India; the Tata family established steel works there at the beginning of this century. Almost from its inception Jamshedpur earned a reputation for being a cosmopolitan, progressive, and paternalistic city, largely because of the careful planning of Tata Iron and Steel Company (Tisco). Tisco continues to administer or to sublet most of the land in the metropolitan area. It and ancillary companies recruited workers and technicians from all parts of India and the world; they provided housing for workers, schools, dispensaries, hospital and welfare services, and supervised markets for their families; and they introduced "progressive" labor practices long before they became standard in India.

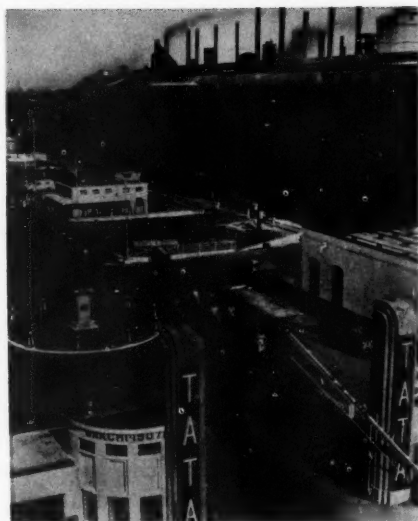
The Jamshedpur metropolitan area covers about 30 square miles and today (1961 census) has a population of 328,044 people. About one third of the population--108,000--are gainfully employed, and about half of these would be employed in factories or related industries. Tisco is the main factory, employing about 30,000 workers. The other firms are mostly engineer-

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ing concerns that process the steel or provide ancillary services. Jamshedpur is one of the most highly industrialized cities in India; it represents an extreme or developed case of the impact of industry, consequently any influence industry has on social life should be most evident in this city.

Indeed the first impression of Jamshedpur that one receives is of a highly industrial and modernized city, one that has been cleanly, orderly, and rationally organized. Industrial smokestacks can be seen from practically every corner of the city, and across a cultivated foreground of tree-lined streets, neat rows of houses, temples, churches, and mosques, and a prosperous looking populace. Company officials pride themselves (with considerable justification) in running a model company and a model town. Their engineers study the latest techniques abroad; officers are trained in modern personnel management techniques; and the families of workers are provided with cradle-to-the-grave community services including a very ambitious and expensive birth control program. Jamshedpur is a city in which factory, home, school, and community have been planned and organized in the interests of industrial efficiency and labor harmony.



Tata Steel Works, Jamshedpur. [Photo: Tata, Inc., New York.]

It is only after living in Jamshedpur for some time and digging beneath the surface that one begins to discover the real character of the city. Jamshedpur is undeniably modern, but it is not an island; it is a relatively highly developed city set within a relatively underdeveloped country, and within one of the least developed and most traditional states (Bihar). People living in the city belong to both of these worlds, to the modernized world of industry and the traditional world. The two worlds do not always conflict, but they certainly contrast.

### Caste and Class

The research problem was to discover the ways in which the workers and their families in Jamshedpur responded to the pressures of modern industrialization. Will their responses help us to predict future trends as India modernizes? The data are still being analyzed, and more need to be collected, but we can make some general statements about

the ways in which social life is organized in terms of class, caste, and kinship, and how this organization appears to represent some compromise or blending of the two cultures of India and of modernity.

Generally and ideally speaking, people believe that caste should have little relevance for life in Jamshedpur. Caste is for the traditional villages, they say, not for the modern towns. Most people were quite clear about this distinction. In the village people traditionally were, and to some extent remain, divided and organized in terms of caste; a person lived, dined, and associated with members of his own community. In the city, on the other hand, people are divided according to class or occupation. To paraphrase one worker, "I live with other workers, eat with them and work with them; I do not move with supervisors or the management, even if they are members of my caste, because they belong to a different class."

A number of the factories have sponsored social clubs ideally open to all employees, but in practice restricted according to one's ability to pay membership fees. There are two or three expensive prestige social clubs for the Jamshedpur "upper class," as well as the Rotary and Masons; and there are a number of smaller clubs with fewer facilities and lower or no fees patronized by members of the junior supervisory and worker classes.

Housing in Jamshedpur is mostly controlled by the companies. About a third of the workers are allocated company housing; an eligible worker has the right to select a house type equal to or lower than his occupational level, but not higher. House lots are also allocated to some employees who wish to build their own homes for retirement, and again the distribution is officially in terms of the occupational levels of the applicants. The purpose of this housing policy is quite explicitly class oriented; it is to encourage people of roughly similar incomes or occupational levels to live together in the same neighborhoods, regardless of caste, language, or religion. The policy has worked fairly well, although there are a few communal clusters here and there (for example, Muslims and Harijans tend to live in segregated areas) and some people covertly lease their houses to others.

Ideally, in the city one should not ask another's caste; nor especially should it be a concern on the job. A person expects to be employed and promoted on the basis of his performance rather than because of his caste. Casteism on the job is not respected by workers and is officially prohibited by the companies.

How does the actual state of affairs in Jamshedpur compare with the ideal? Because caste has long been a pervasive factor in rural life, and most workers retain some rural connections, casteism is also not totally excluded from Jamshedpur. Caste membership is

still important in the city in regulating marriage and sometimes inter-dining. Harijans and several other scheduled castes have their own caste associations and club houses. Service castes continue to provide their specialized services for city dwellers (e.g., the sweepers, cobblers, washermen, basketmakers, merchants, and priests). The caste factor is also not totally excluded from hiring and promotion in the factories. In one factory a department is dominated and almost completely staffed by members of a single caste; some personnel officers have been accused of favoring their own kith and kin, and several have been disciplined for accepting bribes. Aside from these cases, however, the main role of caste in Jamshedpur appears to be as a "means of last resort." Young men will compete for jobs on the basis of merit; but if after repeated attempts a person does not succeed he comes to believe that others were favored over him for personal reasons. The activation of caste ties in the city is thus seen as a necessary evil, whereas in the village it may be considered a virtue.

The people of Jamshedpur--and I do not think they are unlike other Indians in this respect--maintain a pluralistic or relativistic ethical system: "class for the city and caste for the village" is one manifestation of this relativism. There is nothing wrong with switching from one context to the other; there is no inconsistency in befriending or eating with a low caste man in the city and ignoring that same person in the village. Proper behavior is situationally determined more than universally standardized; rather than follow general rules blindly, a man should discover a way of acting most appropriate for the occasion and most suited to his company. A worker therefore adjusts willingly to the demands of city life, and he readjusts with equal ease to the demands of village life when he returns there for the marriage of his daughter, funeral of his elder, or simply for his annual vacation.

### Family and Kinship

This relativistic or situational approach of class for the city and caste for the village represents an attempt to maintain the best of both worlds by keeping them separate or compartmentalized. This can also be seen in the way Jamshedpur workers organize their family and kinship relations. The modernization theory states that, as a result of industrialization, the large joint families will break down into small, conjugal families which will emerge as the dominant type. This appears to be true only in a very limited sense in Jamshedpur, at least judging by our sample of interviews.

To understand how the family organizes in response to urban industrial life it is necessary to examine the different structural dimensions of the family. First, there is the grouping of those relatives who live together under one roof or in one house, which may be called the "household dimension." Second is a corporation of those who share joint rights to property, the "property dimension." And third,

there is the subjective dimension of peoples' idealized models of their own family structure and how they believe their family relations should be organized. Each of these dimensions may respond differently to the impact of industry, therefore propositions that apply to one dimension may have little relevance for the others. For example, the theory predicting a breakdown of large families may actually refer more to the household dimension than to the property group or ideal. The dimensions may also vary according to the socio-economic positions of the members; ideals, residential practices, and property alignments may be partly a function of class.

The ideal family as described by most of the respondents in our Jamshedpur sample is a large, three-generation family of father, sons, and grandsons with all their wives and unmarried children, all sharing the same property, living under the same roof, and eating from the same kitchen. This is the classical ideal of the Hindu joint family shared, I suspect, by the vast majority of Hindus all over India. It is an ideal honored more than it is practiced. It is difficult to implement for a variety of reasons, not the least of which are the problems of finding a house large enough, jobs close enough, and relatives peaceful enough to keep so many people together for so long. This ideal has nevertheless remained fairly stable despite industrialization. In a sub-sample of 106 workers and foremen drawn from our larger sample, we found that 72 percent of the men preferred this ideal over any other. Only 12 percent of the sub-sample--mostly from the "middle class" foremen category--preferred the conjugal family ideal (that is, husband, wife, and unmarried children having separate house and property).

How does the ideal dimension compare with the other two structural dimensions? First, 83 percent of the workers and foremen in the sub-sample of 106 live in conjugal households; only one respondent actually lived in a household structured like the ideal. This distribution of household types clearly reflects the industrial setting of Jamshedpur. All the respondents of the sub-sample live in company-owned quarters and all of these dwellings are designed as single-family units.

Most of the workers in the sub-sample consider their stay in Jamshedpur and in company quarters they rent as only "temporary," however, even though that may mean twenty to thirty years. For most of them household is not the same as family, but constitutes only one segment of it. They subordinate the household to the needs and demands of the larger grouping to which it belongs. Unlike the household, the property group does not appear to be contracting in size. Although 83 percent of the respondents in the sub-sample presently live in conjugal type households, 87 percent claim membership in and rights to the property of joint families larger than conjugal in composition. The property dimension is thus a complete reversal of the

household dimension. Most of those respondents who do not belong to joint families are "middle class" foremen.

The typical property group represented in this sub-sample is a corporate organization made up of, on the average, two to three separate households. Eleven property groups had only one household each, whereas 20 property groups had four or more households each. Despite the separate households, which may be in adjacent lots or hundreds of miles apart, members of the property group share equal rights to the joint property. Typically the household where the elders live, for example the ancestral home at the native place, serves as the headquarters for the property group and custodian of the property. The other households are like satellites, located around the country at places of work or study. Members "orbit" from one household to the other. The parents and unmarried children will live in the native village, for example, while the sons and their wives and children will move to the cities for jobs. The wives of the sons will take turns returning to the native place for three months to a year to care for their parents-in-law or to produce their own children. The composition of a household therefore constantly fluctuates: it may be conjugal in structure one month, sub-conjugal the next, and joint during the third month when brother's or father's family visits for a "temporary" stay of three to six months.

### Impact of Industry

It is my impression that this fluctuating and flexible organization of family members is a typical situation in India, and one of long standing. Members of the property group do not always, and perhaps seldom, live together, but the group still exercises influence over individual members. The property group typically serves as the organization responsible for financing the higher education of its members, arranging marriages, funerals, and other ceremonies, giving refuge and support in times of need, exerting influence to obtain employment for its younger members, and providing a place for retirement in old age.

The organization and functioning of the property group is influenced by the industrial setting only to a limited extent. This is because only one household segment of the group may actually lie within that setting. The impact of industry may reduce the size of households. Industry seems to encourage the dispersion rather than reduction of the property group; its members divide into smaller segments that can move separately and easily to where the jobs are. This scattering of family segments is frequently interpreted as an index of the disintegration of the joint family; but it has several positive consequences for family solidarity. First, segmentary dispersion tends to lessen the immediacy of joint rights and duties thus enhancing in-



dividual freedom and mobility; second, it reduces the opportunities for conflict, for example between wives, thus enhancing cohesion; third, it reduces the pressure on ancestral house and land, thus maintaining or increasing the standard of living; and fourth, it increases the supply of money to the family, thus strengthening it both economically and politically.

The property group is susceptible to a wide range of pressures that are sometimes only remotely connected with industrialization. A worker's retirement possibilities, for example, or his sons' employment opportunities, his daughters' marriage prospects, his parents' or siblings' economic conditions, and his wife's preferences all influence his decision to retain or relinquish membership in the property group. During times of scarcity or insecurity--which most people we talked to in Jamshedpur consider the present to be--a man can seldom afford to break away from his family. His kinsmen need him as much as he needs them; and if he deserts his elders now, he knows that he cannot rely upon his children in the future.

We would conclude, first, that the Indian joint family is thriving rather than dying out; second, that changes predicted by modernization theory are more noticeable among "middle class" foremen than the "lower class" workers; third, that Indians are far more adaptable, and their social institutions (e.g., the multiple residence joint family) far more flexible, than we have hitherto recognized; and fourth, that this flexible joint family system may actually facilitate more than obstruct the adjustment of people to the demands of industrialism by providing for individual mobility as well as familial networks of mutual aid and security. These conclusions appear to be relatively optimistic, and I think justifiably so. It is impressive to observe the resiliency, durability, and flexibility of Indian social institutions like caste and joint family, as well as the adaptability and pragmatism of the individual members.

[Excerpted from "Modernization and Social Structure: Family, Caste and Class in Jamshedpur," Economic and Political Weekly. Bombay: A Sameeksha Trust Publication, Vol. IV, Special Number (Nos. 28-30), July 1969, pp. 1217-1224.]



## The Place of Tradition in Modernization

Lloyd I. Rudolph and  
Susanne Hoeber Rudolph

[Tradition in developing countries, and the "modernity" of industrial countries, are too often treated by scholars as opposites, which makes the process of modernization appear more difficult than it may be. The paths of change need not be the same as those followed in Western history.]

Modernity has generally been opposed to tradition in contemporary analyses of social and political change. This assumption that modernity and tradition are radically contradictory rests on a misdiagnosis of tradition as it is found in traditional societies, a misunderstanding of modernity as it is found in modern societies, and a misapprehension of the relationship between them.

What is usually meant by modernization may be defined as follows: "modernity" assumes that local ties and parochial perspective give way to universal commitments and cosmopolitan attitudes; that calculation and science take precedence over the emotions, the sacred, and the non-rational; that the individual rather than the group be the primary unit of society and politics; that the associations in which men live and work be based on choice, not birth; that mastery rather than fatalism orient their attitude toward the material and human environment; that a man's identity be chosen and achieved, not ascribed and affirmed by tradition.

Western scholars who confine their attention to their own or other modern societies have in this generation

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increasingly stressed traditional survivals. Studies of American political behavior suggest the persistence of such traditional forces as local history, ethnicity, race and religious community. American sociologists studying the fate of the "melting pot" emphasize the importance of ethnic and religious solidarities. The literature on organization reveals that the modern corporation attempts with considerable success to create diffuse affective bonds among not only its employees but also their wives, families, and neighbors. Economic relations among and between employers and employees assume aspects of traditional patron-client relationships. The new urban sociology tells us that the metropolis produces collectivities of urban "villagers." In sum, the recent literature focusing exclusively on so modern a society as America tends to contradict the notion that tradition and modernity are opposites. It suggests instead that there may be certain persistent requirements of the human condition that tradition, as it is expressed in the past of particular nations, can and does satisfy.

When we turn, on the other hand, to the image of modern society that emerges from much of the literature comparing it to traditional society, we find that its traditional features have either disappeared from view or are pictured as residual categories that have failed to yield, because of some inefficiency in the historical process, to the imperatives of modernization. This misunderstanding of modern society that excludes its traditional features is paralleled by a misdiagnosis of traditional society that underestimates its modern potentialities. Those who study new nations quite often find only values and structures that fit a model of tradition, and they miss the latent, deviant, or minority ones that may fit a model of modernity. But all civilizations and complex cultures, whether predominantly traditional or modern, encompass a wide range of sentiments, psychological predispositions, norms, and structures. Analyses that aim to encompass social change ignore these variations at their peril.

The cumulative effect of the misdiagnosis of traditional societies and the misunderstanding of modern societies has been to produce an analytic gap between tradition and modernity. Thus, we find the literature speaking of an abyss between them, stressing incompatibilities between their norms, structures, and personalities, and describing the hollowness of men and institutions in mid-passage. Because they are seen as mutually exclusive, to depart from one is disorienting and traumatic, to enter the other alienating and superficial. If the two systems are taken to be fundamentally different and incompatible, then social engineers working with new blueprints and new materials are required. Change takes on a systemic rather than adaptive character.

The opposition of modernity and tradition is also a natural consequence of the comparative method of analysis. One of the great attrac-

tions of comparative analysis has been to correct excessively narrow perspectives and the parochial judgments they produce by placing any particular instance in the context of plausible alternatives. But interest in comparison has not always been combined with knowledge of and sensibility toward particular non-Western nations. The strongest impulse for comparative work has come from those familiar with Western comparative politics and political sociology. They have, characteristically and understandably, been influenced by categories of analysis and historical possibilities fashioned in their own familiar context. Comparison becomes a way of measuring, and the standards of measure have a way of carrying normative implications. The consequent assumptions and inquiries have the effect of limiting the models of modernity and the processes and sequences of modernization to the experience of Western nations. The myths as well as the realities of Western experience set limits to the social scientific imagination, and modernity becomes what we Westerners imagine ourselves to be.

#### The Indian Case

It is important to accord tradition a higher priority in the study of modernization than has often been the case in previous analyses of it. By placing Indian manifestations of tradition in the foreground of observation, we are better able to explore its internal variations and potentialities for change. The examination of internal variations within traditional and modern societies draws attention to those features of each that are present in the other. If tradition and modernity are seen as continuous rather than separated by an abyss, and if internal variations are attended to and taken seriously, then those sectors of traditional society that contain or express potentialities for change from dominant norms and structures become critical for understanding the nature and processes of modernization. Classes and castes, religions and sects, statuses and roles that represent deviations from dominant motifs: stresses within dominant ideologies, and recessive themes in cultural patterns and psychological make-up that can be mobilized by somewhat changed historical circumstances, all become grist for the mill of social change. The components of "new" men may exist among the "old."

Gandhi's leadership illustrates some of these observations. It would be difficult to place him with either the new or old society, although his symbolism was traditional. His ideology and tactics stressed non-violence, asceticism, compromise and consensualism, themes that are susceptible either to a fatalistic and other worldly interpretation or to an activist and this-worldly one. In fact, Gandhi harnessed them to the requirements and purposes of a modern mass movement whose goals were national independence, coherence, and self esteem. The potential for activism and mastery of the environment had always

been there: changed historical circumstances provided an opportunity for its expression.

Comparative stratification studies, for example, have tended to view the Indian caste system as an approximation of the ideal type: a system in which rigidly ascribed and closed status groups, whose superordinate and subordinate relationships are legitimized by a comprehensive sacred ideology, block social mobility and change. Much of that image has always been correct. But we are now beginning to recognize that earlier interpretations based on sacred texts took too literally their descriptions of social organization, and assumed too readily the social validity of their legitimizing values. The ideology of these texts, written by Brahmans, obscured the reality which included considerable mobility and social change. Conquest and novel economic opportunities often enabled alien or subordinate peoples or castes to establish themselves within the traditional system. These groups were provided with names, symbols, genealogies and ritual rank appropriate to their newly won power and status. But by the time British ethnographers got to work, these events had disappeared from view: castes which might have established themselves as recently as the 17th century were presented in terms of ancient Vedic social structure, with the clear implication that they had been in place since time immemorial.

Psychological theories of entrepreneurship provide another example of how potentially modern features of traditional Indian society have been hidden from view. Entrepreneurship in the modern West has often been linked to a character structure associated with Protestantism or early liberalism, both conspicuous in India by their absence. Yet new historical and anthropological research suggests that the ethic and character of traditional merchant castes could be channeled into behavior appropriate to capitalist entrepreneurship within the framework of continuing familial and community obligations. Even more recently, new studies have revealed how many Brahmans, socialized as a literary and priestly class but blocked by contemporary events from occupying such roles or their modern equivalents, have shown capacities for economic enterprise.

### New Patterns of Change

Our argument concerning the modernity of tradition and its correlate, that modernity incorporates traditional aspects, is based on a rather different view of historical sequences than many comparative analyses of modernization in new nations. The latter are often expressed in terms of prerequisites or conditions, certain levels of industrialization, urbanization, literacy, mass communications, and so on, which must be realized before modern behavior in the economic, social and political realms can be established. By relating such factors through statistical analysis to aggregate characteristics of

systems, these theories attempt to establish when and under what conditions such aspects of modernity as political democracy or social mobilization are possible and viable. Although there is no mention of necessity or inevitability in such theories, they do tend to assume that some processes and sequences are related in predictable ways to certain historical end products, like political democracy. But must we assume that because in modern Western nations particular conditions preceded the emergence of modern societies they will or must be repeated in our own era to produce the same results?

Although certain historical repetitions and coincidences are surely to be expected, there are compelling reasons to believe that different processes, sequences, and relationships are probable. Knowledge of what has happened in history, of what is available from the political, economic, and administrative experience of "modern" nations, and of what is transferable from the accomplishments of science and technology, creates new possibilities. Certain alternatives that were not available to 17th and 18th century Europeans and Americans are today not only available but taken for granted in many new nations.

Western observers often view the aspirations and ambitions of new nations in the spirit of the father who finds his son taking for granted the birthright that he has labored long and arduously to produce. He mistrusts the son's assumption that he can take as a starting point what his father has made available without experiencing in considerable measure similar trials and tribulations. There is, however, another side to such historical moments. The techniques and methods, the values and structures, the character and behavior for satisfying the aspirations of new generations and new nations, are known and available. They can be used or abused. New nations do not find themselves in the situation that Europeans did 200 years ago. The world knows how to build a steel mill, both in the narrow technical sense and to some extent, in the wider social sense. It knows the capacities of scientific agriculture even though poor and ignorant Indians, like poor and ignorant Americans, may take some time to use them effectively. Experience with cultural and technical innovation has made it abundantly clear that we cannot expect lessons that history has to teach to be easily or happily learned. At the same time, there is no doubt that the environment of change and innovation in the mid-20th century is radically different from that of the 18th; many historical processes and sequences have been telescoped or eliminated, and some have even been reversed.

[Excerpted from The Modernity of Tradition: Political Development in India. Chicago (Ill.): The University of Chicago Press, 1967, pp. 3-14. Copyright © 1967 by The University of Chicago.]

## An Institutional Analysis of Development in Mexico

James V. Cornehl and  
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[Despite rapid development in its modern sector, Mexico remains a dual society with much of its population excluded from economic gains by cultural barriers more persistent than is usually thought.]

The Mexican Revolution is one of the most thoroughly studied Latin American historical events of this century. Fifty years after the start of the Revolution, however, scholars find it possible, depending on the criteria selected, to argue with almost equal plausibility that the revolution has been either a success or a failure. It is frequently cited that some 50 million hectares of land were distributed to peasants, that the volume of agricultural and manufacturing output grew 289 percent and 628 percent respectively in the period 1939-64, that real per capita income more than doubled from 1,150 to 2,350 pesos in the same period, that a thoroughly Western concept of labor and property rights was embodied in the Constitution, that foreign domination of basic economic sectors was broken, that the mortality rate fell by two thirds from 1910 to 1960, that the illiteracy rate was halved in the same period, that a basic infrastructure was completed, and so on through a long list of accomplishments.

But critics of the revolution direct attention to some rather glaring defects amidst the panorama of achievements, and some even conclude that on balance the debit side is greater. It is pointed out that Mexico has

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failed to develop a substantial industrial base, has a crude death rate higher than Bolivia and Peru, continues with 37 percent of the people illiterate, and still has a substantial caloric dietary deficit. The most severe condemnation of the Revolution stems from the continued existence of grinding poverty for a substantial proportion of the populace and the highly unequal distribution of the fruits of revolutionary change. In 1957, 50 percent of Mexican families received only 15 percent of the national income, while 80 percent of all families earned less than the average monthly family income of \$56. At the other extreme, political favoritism and widely reported graft and corruption among governmental officials have helped create a class of nouveau riche living in the opulent residential areas of Mexico City and the regional capitals.

The conclusion reached by most observers, critics and proponents alike, is that the Revolution has accomplished a good deal but still has far to go before it is finished. Both critics and champions usually base their cases on the degree of success attained by Mexico in reproducing a copy of Western developed industrial-commercial economies. A great deal of the difficulty in arriving at conclusions regarding the success or failure of the Revolution stems not so much from the available data, which are common property, but from a too narrow basis of evaluation which ignores significant economic and social features widely prevalent in Mexican culture.

Mexico remains a two-tiered social and economic system. The rural population has been left almost completely outside the overlay of Western-style progress mirrored in the conventional aggregative indicators, as has a rather substantial urban group only recently emerged from the village. The accomplishments cited for the Revolution are the record of the upper tier; they are decidedly not the record of the lower tier. The shortcomings of the revolutionary movement are concentrated within a rather clearly defined population bloc, to which it will be useful to refer as the peasant or indigenous economy.

#### The Indigenous Institutional Pattern

Roughly speaking, the indigenous economic system encompasses the lower tier of the Mexican national economy, though it has important vestigial manifestations throughout the Mexican social system. In 1960 about 10 million out of some 28 million people over six years of age could be clearly identified as belonging in the indigenous pattern. They are characterized by very high rates of illiteracy. They do not eat wheat bread; the maize tortilla as a dietary staple has great cultural significance. They eat very little meat, eggs, milk and fish, and go barefoot or wear huaraches or sandals, another feature of cultural significance in Mexico. The great bulk of them are associated with rural life, but there are several millions to be

found in smaller towns and the great slum districts surrounding Mexico City. Available data indicate that while this marginal population has declined in percentage terms over the past 50 years, it has remained constant or increased slightly in absolute numbers during the same period.

The indigenous economy can best be understood in terms of Eric Wolf's two main typologies of Latin American peasantry. The first, the corporate community, may be characterized as a subsistence economy with very little output for cash sale. Production generally flows into an interlocking system of village markets. The important features of the corporate community are that it constitutes an integral social and economic system which clearly delineates and exercises control over the relations of its members with the outside community and which clearly limits and defines internally the rights and duties of its members while prescribing large segments of their behavior. The corporate structure is maintained through community control over the disposal and use of lands. Power is delegated through non-economic mechanisms, especially religious and political office. A quasi-automatic leveling or redistributive mechanism operates to proscribe wealth differences which might lead to economic stratification injurious to the maintenance of the community social structure. While divisions of a hierarchical nature exist, they are not based on economic considerations. The corporate community is a form of socio-economic organization which dates from pre-conquest Mexico and which has displayed a remarkable capacity for persistence throughout the years of Spanish colonialism, independence, and the post-revolutionary period.

The second Latin American peasant type, the open community, involves peasants who for one reason or another have entered into commercial crop production and regularly sell from 50 to 75 percent of their output outside the village. They have in effect begun to link a part of their economic fortunes with those of the outside world. In many instances the major impetus has come from windfall opportunities deriving from international demand for such products as sugar, coffee, rubber, and henequen. The distinctive features here are the increasing resort to outside credit, often at extortionate rates, while the peasants become dependent on price fluctuations beyond their control and must realize cash income to satisfy a fairly large proportion of ordinary living expenses. There is a partial breakup of non-economic ties characteristic of the corporate community structure and an increasing emphasis on individual accumulation and display of wealth as a distinguishing feature of social stratification. Private ownership and individual control of land use increases, along with increased mortgaging and sale of land and crops. Yet, despite contact with commercial production, there is continued use of primitive technology and small plots because highly capitalized and reorgan-

ized production techniques may lead to financial ruin and loss of lands whenever the bottom drops out of a market. Closer ties with the town are developed and especially with urban families whose fortunes have become involved with local production of the cash crop. One consequence is the substitution of personal ties between urban family power blocs and their peasant clients in place of corporate community ties. A pattern of reciprocal obligations and mutual assistance between patron and client is established which is more consistent with the familiar village pattern of economic relationships than would be the case with greater reliance on the impersonal market mechanism.

In the corporate community, and to a lesser degree also in the open community, economic relations form part of a larger web of social relations wherein the economy remains embedded in and subservient to the wider interests of the community. Each individual is guaranteed by virtue of his membership in the community a level of economic wellbeing consistent with the fortunes of the village as a whole. In the corporate community individual accumulation of wealth is frowned on, and redistributive mechanisms operate through expenditures for community religious festivals and the exercise of public office with only modest remuneration. While increasing accord is given to the display of wealth as a form of social distinction in the open community, and outlook is extended beyond the village, economic rights, obligations and transactions are still heavily circumscribed by accepted canons of behavior and by the town-patron peasant-client relationship.

The widely-held view that the open community represents a non-reversible, stage-like development or movement into a market-regulated economy is unsubstantiated. Two factors militate against such orderly progression. First, the economic viewpoint of the peasant is not significantly altered; allegiances are merely extended beyond the corporate community on a temporary basis. And second, since increased gains from the sale of cash crops are largely absorbed by middlemen, reorganized and technologically more efficient production is rendered impossible. When prices fall and the town-country relationship is severed, subsistence production may be resumed without heldover heavy debts stemming from capitalization and the attendant risk of loss of lands and livelihood. There is, moreover, strong attachment to ownership of a plot of land, and it is common to encounter "uneconomic" exploitation of land in rural Mexico (uneconomic insofar as the owners could earn more by working as wage laborers). But corn for the villagers' consumption is the guarantee of security and is basic to the village economy. Security is the hallmark of village social organization. To move completely into the cash nexus of the commercial economy would not only disrupt social relations within the village structure but would put the peasant at the mercy of market forces beyond his control. In terms of his own view of wellbeing, such behavior would be folly.

Gradations of peasant communities ranging from the corporate through the open type are prevalent throughout rural Mexico, and the social and economic behavior associated with village culture is partially carried over into economic and social relations in the towns. While the corporate community is on the wane, remnants and modified versions of it contribute heavily to the lower tier of Mexicans who remain on the fringes of the more prosperous commercialized community.

### The Conflict of Cultures

In Western culture, as in the Mexican commercial environment, economic functions are separated out to a large extent from the composite institutional grid. Patterns of behavior falling within the purview of what is ordinarily considered economic are subject to a wide margin of freedom. Activities unfavorably regarded in many social contexts--sharp practices, and the refusal to reciprocate friendship, for example--are considered perfectly permissible within the realm of economic activity. Where social sanction breaks down as an operative force in curbing abuses in a Western environment, legal enactments may be instituted to replace them.

Ignorance of one's cultural environment is capable of producing a sense of alienation, of non-belonging which severely limits the capacity of the individual to function successfully. Whenever possible, the effort is made to circumvent these difficulties through the recreation of the more familiar environment--hence the enclave societies within alien environments. The commercial world is the expression of such an alien culture for millions of Mexicans. Its emphasis on impersonality and on the accumulation and display of wealth as the measure of social distinction are foreign to the lower tier of Mexican society. The tenacity of elements of the corporate community structure in the face of the Mexican nation's Westernized development acts as a counterpoise to the harshness of the changes wrought by the partial adoption of Western values. Within villages in transition which have already become partially involved with the commercial economy, traditional attitudes toward wealth and work remain in abundant evidence. For example, the Popoluca Indians in Veracruz, after more than 50 years of contact with coffee production as a cash crop, have left all extra-village trade in the hands of outsiders, have retained the tradition of obligatory lending to villagers in need without interest charges, would not buy or sell village lands, maintain obligatory reciprocal work arrangements with fellow villagers and may be characterized as an economically classless society.

The non-commercial culture of the peasant, however, limits his capacity to make the best of the cash situation, while the continued attachment to village social patterns prevents his complete change-

over to commercial farming. When members of the lower tier move outside the familiar environment of the indigenous economic system into the commercial-industrial world they become easy prey to sharp business practice because they almost wholly lack expertise in commercial transactions. Furthermore, the peasant seldom realizes a great enough return from his partial commitment to commercialism to effectuate improvements of a lasting nature. Technological changes which would transform agricultural production on a permanent basis are thus inhibited, and the cycle of low yields and low income is perpetuated, as is dependence on the middleman. The inability of the peasant to operate effectively in the commercial sector leads to an increasingly skewed income distribution as the bulk of increased earnings is concentrated in urban pockets. Local markets with stable or fixed prices are undermined by initially cheaper goods from the nearest urban center. Local products fall into disuse and local producers are forced to shift back into subsistence agriculture or abandon their village. Subsequently, when the national money economy experiences inflation the peasants' living costs rise, forcing a downward shift in living standards and shifting income distribution in favor of the urban areas.

As a by-product, pressures on communal lands increase as inflation drives land values up and some private landowners rent out their plots and invade the communal lands for the production of their own subsistence crops. This invasion by peasant landowners of communal lands, generally reserved by accepted social practice for needy villagers, creates resentment and divisiveness in the village. In general, as commercial values are adopted by deviant members of the community the result is the emergence of the petty entrepreneur and moneylender, whose rapaciousness in economic relations is thought to be among the worst in Latin America. While Western developed nations have instituted legal controls to curb such abuses, no such controls exist as yet in Mexico.

Where living standards fall and pressures mount on the use of village communal lands, peasants are driven off the land and flock to metropolitan areas. Ill-prepared and unaccustomed to their new environment, they drift into menial service jobs, enter petty commerce selling everything from shoestrings to lottery tickets in the streets, and form the now familiar urban barriadas. Many become domestic servants, an arrangement which recreates in numerous small ways the familiar environment of guaranteed subsistence of the corporate community structure within a well-defined hierarchical system. Unemployment and underemployment become widespread. Non-Western value oriented economic and social enclaves which remain outside the mainstream of commercial-industrial Mexico abound along the peripheries of commercial centers. Urban slum dwellers provide many examples of social cohesiveness and the reciprocal arrangements of the



indigenous economy, as do numerous villages in transition. The care and feeding of children, the sharing of meager belongings with relatives and friends recently arrived from the village and the development of compadrazco as an institution for exchange of favors, a reliable source of borrowing in time of need and a channel for providing semi-obligatory contributions to defray funeral expenses all represent partial attempts at recreating familiar peasant community economic and social relations.

Vestigial elements of the reciprocative, hierarchically ordered economy also are to be found within the upper tier of Mexico's economy. Relations among the old guard of Mexican businessmen are characterized by a high degree of personal loyalty and mutual cooperation, reinforced by social sanction and familial ties. The same can be said for relations between employer and employee and within the government bureaucracy. A closely interlocking network of reciprocal relations insures that "business as usual" will be carried on through familiar and well established channels, even though opportunities abound to effect transactions more advantageously. One of the side effects of this process for many years was to confine a good deal of Mexico's industrial development to a relatively small circle of industrialists whose connections with the government and principal sources of finance placed them in a strategic position to exercise control over industrial and commercial developments. The clash between the old and the new is nowhere more evident than in the growth of conflict between the old-guard business interests and a new breed of industrialists fostered by foreign capital and special institutions of the Federal Government. The latter seek the more complete development of market capitalism tied to the international economy.

### A New Approach Needed

One may conclude that failure to grasp the significance of the two-tiered economic and social structure in Mexico has led to aggregative policies which have not only failed to deal with the problem because it goes unrecognized, but have contributed to its accentuation in failing to promote orderly progress for a majority of the Mexican people. A bias arises from viewing the indigenous economy as inherently inferior and hence unacceptable as a basis for integral development. The dominant view is that the indigenous economy represents an undesirable form of economic organization because it is seemingly unsuccessful in competition with the industrial-commercial system and because of its presumed inability to foster technological improvements. This presumed inability may be partially attributed to the inhibiting character of its contacts with the commercial sphere and partly to the failure of public institutions to support it as they have supported Western commercial-industrial enterprises. Where comparable efforts were made, among the cooperative ejidos of the



Yaqui valley under President Cardenas in the 1930s, the peasant economy developed rapidly and mechanized agricultural production successfully. But the primary thrust of Mexico's economic policies has been the effort to draw the indigenous economy into the commercial-industrial economy. The result has been the persistence of a large rural poverty bloc which fails to respond in the conventional way to commercial incentives and is not absorbed into the economic overlay, while being shorn of its security and of the opportunity to progress in its own fashion.

[Excerpted from "Economic Development in Mexico and Thailand: An Institutional Analysis (Part One)," Journal of Economic Issues. Boston (Mass.): the Association for Evolutionary Economics and the University of Massachusetts-Boston, Vol. III, No. 3, September 1969, pp. 16-28.]

[NOTE: For a different view on Mexico's "lower tier," see Development Digest, October 1970, pp. 65-70.]

# EMPLOYMENT IN AGRICULTURE



FARMERS CULTIVATING POTATO FIELD, COLOMBIA  
[PHOTO: FOOD AND AGRICULTURE ORGANIZATION OF  
THE UNITED NATIONS]

## Employment Generation in African Agriculture

Carl Eicher, Thomas Zalla,  
James Kocher and Fred Winch

[Employment in African agriculture would be much enhanced by a greater use of animal power and an avoidance of tractor projects which depend on subsidies. Employment could also be increased by expansion of export crops and by more attention to small-scale rather than large irrigation projects.]

Rising unemployment in Africa is a major social, political, and economic problem. A convergence of forces, including policies favoring urban-based, capital-using development and the population explosion, has led to rising rates of unemployment which are expected to increase in the 1970s. Only a modest percent of the increase in population will be able to find jobs in Africa's urban centers. There is now a consensus of opinion among researchers that over the next 10 to 15 years solutions to employment generation in Africa will have to be found to a large degree in the agricultural sector. However, with the exception of a few countries such as Tanzania, the Ivory Coast, and recently Nigeria, African political leaders have not made a commitment to employment generation in agriculture. Likewise, most African political leaders have adopted a "wait and see" attitude to checking the population growth rate through family planning as they see few short-term political gains from launching a family planning program.

The paradox of migration from rural to urban areas in the light of open unemployment in urban areas and

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positive labor earnings in agriculture may be explained: it becomes rational to migrate to urban areas even if there is only a 50 or 33 percent probability of finding a job when the average wage in the urban areas is two or three times the average agricultural income. Policy-makers who are preoccupied with finding an urban "solution" to unemployment problems can expect their policies to induce more migration from rural to urban areas. Therefore, an efficient strategy for coping with urban unemployment problems must address itself to employment generation in agriculture. Present techniques of investment analysis contain a built-in urban bias because they usually do not include as a social cost the differential complement of urban amenities involved in creating employment in urban as compared with rural areas.

In contrast to Latin America and Asia, Africa does not have major land tenure problems which require public action and land reforms. Africa's predominant system of smallholder production is remarkably capable of absorbing labor, provided incentives are available at the farm level. Even when there is not a clearly defined land market, there is evidence that land bottlenecks will "yield" in East and West Africa when profitable investment opportunities are forthcoming.

Some of the major causes of unemployment in agriculture in African countries are linked to poor agricultural policies:

1. Subsidized big-tractor mechanization (40-60 horsepower).
2. Anti-export agricultural policies.
3. Self-sufficient food policies which may raise consumer prices and induce higher minimum statutory wage rates.
4. Overemphasis on direct government production schemes which are capital intensive--a) state farms, b) land settlements, c) irrigation.
5. Lack of national research and development policies and programs which are geared to the factor endowments of the nation.

#### Subsidized Tractor Mechanization

African governments have experimented with a number of tractor mechanization schemes and tractor hire services. Tractor mechanization has been generally connected with large-scale farming schemes such as state farms, land settlements, etc. Many of these large-scale mechanized systems of farming have failed after a few years or have experienced so many problems that they have been curtailed as far as was politically possible. Some of the more famous unsuccessful large-scale schemes are government plantations in Sierra Leone, state farms in Ghana, farm settlements in Southern Nigeria, Nigeria's Mokwa scheme and settlements in Tanzania during its First Plan. Also, tractor hire schemes have been generally inefficient in Tanzania,

Uganda, Ghana, Morocco, and Nigeria and other countries in that the financial profitability of the schemes depended on subsidies.

Tractor mechanization schemes in Africa have been less than successful for a number of reasons: the short life of tractors and equipment due to corrosion and poor maintenance and operation; poor management; a low degree of utilization; equipment inappropriate for African soils and diverse ecological conditions; and problems associated with poor land clearance and size of fields. These are problems as viewed by individual farmers, firms, or government agencies. If tractor schemes are carefully scrutinized from a national economic point of view we observe that: tractor schemes are often subsidized by government by means of a number of direct and indirect methods such as capital investment allowances, rebates on petrol, subsidized training centers for tractor drivers, subsidized repair centers, etc. However, these subsidies often go unnoticed by technical agricultural agents, politicians, and donor countries. In addition, tractor schemes require large amounts of foreign exchange for new equipment extensive inventory of spare parts, fuel, etc. Further, the employment effect of tractor schemes is often ignored.

In light of these problems and considerations, the question arises as to why tractor schemes are endorsed by so many African governments and aid agencies and why tractor schemes continue to be promoted and subsidized by African governments. There are many reasons for this continuing appeal: Prestige--tractors and mechanized farming are equated with modern farming in developed nations. Inadequate methods of appraising mechanization projects--tractor projects are usually appraised on a narrow technical or financial basis. Even when mechanized projects are appraised within a national economic framework, important secondary considerations, such as employment, are often ignored. Tied aid--in numerous cases implicit or explicit support for mechanization can be traced to "tied aid policies" of donor nations. Alternatives to "unresponsive" African smallholders--although research has shown that African farmers are "economic men" to a remarkable extent, there are still many government civil servants, especially technical agriculturalists, who see mechanized farming as a shortcut to the tedious process of helping small farmers improve their farming systems. Timeliness--in numerous countries physical soil conditions allow only a few days between plowing (after the rains begin) and sowing. Since present animal power systems can plow only 1/2 to 3/4 acre per day, the cultivated land area is limited. Rainfall patterns and soil conditions that permit only a few days between plowing and sowing in some African countries might warrant subsidized mechanization, despite widespread rural unemployment and underemployment.

Remarkably few external donors use a rigorous cost/benefit approach in appraising tractor projects. Too often they rely for pro-



ject appraisal on technicians who, unfortunately, sometimes justify mechanization in terms of horsepower per unit of land area. For example, a recent report notes that:

There is a shortage of farm power in Equatorial Africa, over 99 percent being derived from human effort. A human being has been rated at about 1/10 horsepower, while the minimum power requirement for an efficient agriculture has been estimated at about 1/2 horsepower per hectare.

Rules of thumb such as 1/2 horsepower per hectare are useless from a practical as well as a planning point of view. The planner needs to know how the rate of return on the investment in a tractor scheme compares with investments in irrigation projects, feeder roads, smallholder credit schemes, plant breeding programs, etc.

Improved techniques for appraising mechanization projects are urgently needed in order to evaluate more fully the pros and cons of subsidizing tractors in Africa. Appraisal of mechanized projects should be undertaken from two points of view: 1) financial, i.e., the profitability of mechanization to the farmer or agency, and 2) the impact of the project on the national economy, including secondary costs and benefits such as the impact of the project on employment, foreign exchange, and other national aggregates. Appraising tractor schemes from only a financial point of view often supports inefficient and counterproductive tractor mechanization. Financial returns are essentially returns calculated at prevailing market prices for inputs and outputs. As such, they usually do not allow for a number of artificial incentives such as the subsidized elements mentioned above, and as a result lead to an exaggeration of the gains from using machinery to replace manual labor. In addition, the administrative and training costs are often not included in the cost of the schemes. Moreover, crops which lend themselves to mechanization--e.g., wheat and sugar--may benefit from producer prices which are enhanced by high levels of protection, so that schemes which will be profitable to the producers may be difficult to justify from the viewpoint of national output. In essence, financial returns are little indication of the project's contribution to national income. In a national economic appraisal, prices are corrected for the imperfections discussed above, and indirect costs and gains are, or should be, added in.

One of the few mechanized projects in Africa that has been appraised from both a financial and a national economic point of view is the Shashemene Agricultural Project in Ethiopia which proposes an investment of \$5 million to help establish 140 Ethiopian farmers in mechanized units of either 40-, 80-, or 200-hectare farms. The mechanized farms are to be subsidized inasmuch as the farmers will not pay for the overhead costs of the project, about \$2.8 million of

the \$5 million total. The financial rate of return to the farmers on each of the three farm sizes and the economic rate of return are considered to be favorable. The internal rate of return on the project to the Ethiopian economy is approximately 20 percent. Although there are several key assumptions which can be questioned--such as tripling crop yields within five years of the project--the Shashemene project is significant for including both the financial and economic rates of return on the project. However, this project appraisal can be faulted for making only passing reference to the impact of the project on employment and on the incomes of non-participating farmers throughout the country.

### Animal Power as an Alternative

Having raised major reservations about subsidizing large-tractor mechanization, let us explore the leading alternative: animal power. In tropical Africa the use of animal power for farming is not widespread, in part due to its late introduction in most African countries, the distribution of the tsetse fly, and the general separation of cattle herding and crop farming. The introduction of animal power has the potential for decreasing underemployment, primarily via extension of the land area under cultivation. The marginal returns from additional acreage could provide sufficient incentive to increase family and hired labor for weeding and harvesting. Laurent suggests that animal power in Northern Nigeria has the potential to extend cultivated area three to four times; in The Gambia, farmers trained at one of the Mixed Farming Centers were able to extend their acreage in groundnuts by 30 to 40 percent; in the Mwanza and Shinyanga Districts of Tanzania the ox-plow has made it possible to extend the area under cultivation by 80 percent compared to traditional methods. In countries or regions where animal power is justified, the domestic manufacture of implements--ox carts, donkey carts, plows, etc.--can also help generate local employment. (Past government efforts to promote animals for draft have generally included only token expenditures on research and development of animal-powered equipment as compared with emphasis on promoting the use of animals to perform one task--plowing.) Other advantages of animal power are yield increases, easing the drudgery associated with handhoe methods, physical adaptability to small farm units, and the gains from incorporating cattle into the farming system.

In general, animal power appears to us a more feasible approach to improving the welfare of smallholders than tractor mechanization in many African countries, given their present stage of development and the existence of pervasive underemployment problems. Our judgment is based upon the following hypotheses:

1. The acquisition price of oxen and equipment is within reach of many more small farmers.

2. The purchase of animal-drawn equipment will require less expenditure of foreign exchange per unit of output than tractors, auxiliary equipment, spare parts, fuel, etc.
3. Animal power will require less investment in supportive services and skilled manpower.
4. Returns on investments in animal power are less sensitive to yield and price fluctuations.
5. The costs of failure for an animal-powered mechanization scheme will be less because of higher relative salvage prices for the inputs.
6. Animal-powered mechanization has lower managerial requirements and is less sensitive to poor management than tractor mechanization.

Promoters of tractor mechanization are often harsh critics of animal-powered mechanization. They contend that once farmers have an opportunity to see tractors in their area, they will want to bypass the animal-powered stage and move from the handhoe to the tractor stage. This may be true: for example, if a farmer can join a highly-subsidized mechanization scheme, why should he pursue animal-powered mechanization? But when a project costs a million dollars and benefits only 100 farmers, the opportunity for the average farmer to participate can be compared with a lottery game. The virtues of using government funds to "educate" farmers to prefer tractors in this way may be questioned.

Critics of animal-powered mechanization also assert that such mechanization simply extends the land area under cultivation and generates a weeding bottleneck. This criticism is generally valid; numerous studies reveal that farmers who adopted animal-powered land preparation techniques are faced with labor shortages during the weeding period. This means, of course, that employment is generated faster than it can be taken up locally in a short time--not necessarily a bad result. But if it should persist on a large scale, it would indicate the need to expand research on weeding devices which can be attached to animal-powered tool bars.

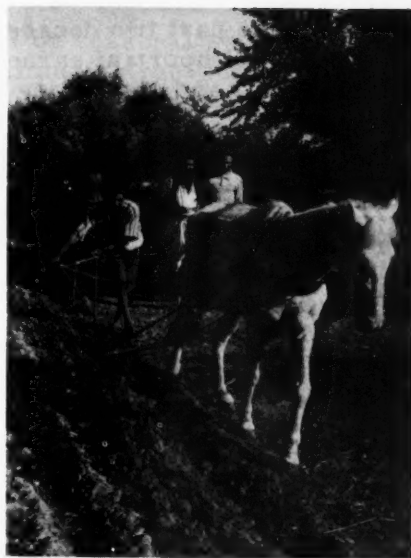
In summary, the case for tractor mechanization in Africa should be critically reconsidered on a country-by-country basis in light of the general failure of tractor schemes, widespread underemployment and unemployment and the potential unfavorable impact of mechanization on employment, foreign exchange, etc. There is a limited role for unsubsidized tractor mechanization in some areas of Africa. However, there is a much larger scope for animal-powered mechanization than is commonly believed. There is an urgent need to develop the research capacity within Africa to design the mechanical technology appropriate to the factor endowments of each country and for varying ecological zones within countries. The challenge for donor agencies

in the 1970s is to shift their attention from the importation of mechanical technology from Europe to assisting African nations in the design and adaptation of mechanical technology appropriate to local factor endowments, i. e., to design techniques which will complement labor use rather than replace it.

### Anti-Export Agricultural Policies

An important cause of unemployment in African agriculture arises from poorly conceived and inconsistent policies for exploiting Africa's potential to compete in world agricultural export markets, and thereby to generate employment and increased effective demand in agriculture. Fiscal policies which tax agricultural exports have helped widen the rural-urban real income gap in a number of African countries. Although export taxes are administratively tidy, they frequently depress producer incomes, promote rural to urban migration, restrict the rise of rural land values, and hold down the growth in effective demand among farm people. Another common anti-export agriculture policy is the requirement that estates and plantations pay statutory wage rates. When the Morgan Report on wages was accepted by the Nigerian government in 1964, for example, government wage rates were increased 20 percent, and private estates and plantations increased their wage rates and quietly reduced their labor force. One private estate in Nigeria, for example, responded to higher wages by laying off 400 workers and substituting chemical spraying of weeds for the machete technique.

Another factor which holds back specialization in export crops is the uncritical acceptance of gloomy export projections. Many African countries uncritically accept the United Nations Conference on Trade and Development (UNCTAD) conclusion that export crops are doomed. Unfortunately, there are not many well documented studies of export markets for African crops, and few African countries--especially the smaller nations--have the analytic expertise to compare payoffs on exports and to develop export crop production campaigns which are based on physical and financial data. But Africa has shown in practice that it can be a low-cost producer of a number of tropical agricultural exports in world markets. The dramatic inroads that African countries have made in the world coffee and tea



Demonstration of steel plow introduced by an FAO expert, Libya. [Photo: Food and Agriculture Organization of the United Nations (FAO).]

markets in the past two decades, for example, suggest that agriculture can be an important earner of foreign exchange, absorbing labor in agriculture, and generating effective demand among farm people to enable them to purchase a higher protein diet, industrial and consumer products, etc. Although iron ore or bauxite may employ a few thousand workers in Guinea or Liberia and may generate high GDP growth rates, the impact of expanding such production on employment is negligible as compared with policies which affect the investment decisions and allocations of labor on hundreds of thousands of small-holdings in these same countries.

Autarkic food policies. Policies which attempt to reach self-sufficiency in production of all food items are a common feature of almost every African plan. In marked contrast to many Asian nations, most tropical African countries are virtually self-sufficient in staple foods. Dalton analyzed the structure of food imports in Africa for the 1963-65 period and concluded that: 1) Only a quarter to a third of food imports (as of 1963-65) could have been effectively supplied by African farmers, on their own, or helped by marketing, transport and extension actions. 2) Foreign exchange gains from easily available import substitution foods are relatively small in terms of need. 3) Food imports are largely a matter of new demands (for wheat flour bread, tinned milk, processed fish), special demands of foreign communities, and of government policy. Since the world price of most cereal products is expected to decline in the 1970s following expanded output of foodgrains in Asia, it is necessary to examine the merits of pursuing self-sufficiency in all food items in African countries--especially crops such as wheat, dairy products, and processed foods such as tinned milk.

Autarkic food policies in many African countries have been combined with rising import duties in order to protect local producers of some crops such as sugar, wheat, etc. As a result, consumer food prices have risen in many countries. The combination of these rising food prices and trade union pressure has induced statutory rises in government wage rates, which are usually adopted by private estates and plantations, and these have often led to the replacement of labor with capital equipment.

#### Overemphasis on Direct Government Investment Schemes

Another cause of unemployment problems has been the rush into direct government production of agricultural products on large state farms and land settlement schemes. Large-scale irrigation works associated with such schemes dot Africa, especially in the north and in the Niger and Nile river basins, and it has been estimated that the extent of irrigation in Africa could be substantially expanded. Much



of the potential area consists of perennial or seasonal swamps: if such immense areas are ever to be reclaimed, large-scale pumping and drainage facilities will be required. Needless to say, such programs will be expensive. Unfortunately, successful large-scale irrigation schemes in Africa south of the Sahara are few and far between; an outstanding exception is the Gezira scheme in the Sudan. The major problem with large-scale irrigation schemes of any type is the large capital expenditure required and the relatively few people affected by them. These large schemes also require a considerable degree of coordination--from the engineers who build the pumping station and the dam to the agency that distributes the water through the canals, to the extension specialists who must train the farmer. Management is a critical ingredient which unfortunately is not always available as required.

Although large-scale irrigation schemes have generally been unproductive in tropical Africa, we believe that there is long-term potential for small-scale irrigation to absorb labor through constructing and maintaining irrigation systems and through multiple cropping. It is important to point out that the substantial irrigation infrastructure in Asian countries such as Taiwan, Pakistan, and the Philippines was established over the past three or four generations, and that vigorous government research programs on irrigation have been standard for a number of years in Asia. Because of the lack of such an infrastructure in tropical Africa there is no reason to be optimistic about any major expansion of smallholder irrigation within the next few years. However, the potential of employment generation is so great that steps should be taken now to expand research on smallholder irrigation. A substantial amount of rural unemployment and underemployment in Africa is seasonal in nature. Farmers are unoccupied for periods of one to seven months each year. While it is true that during the slack season homes are repaired, implements are manufactured, clothes are made and petty trading takes place, some of the labor undoubtedly represents disguised unemployment--i.e., the same work could be performed by a much smaller labor force. Irrigated agriculture can productively utilize farm labor during slack periods, as well as increase yields on crops grown during the normal cultivating season. The net result of irrigation should be a significant increase in agricultural output, incomes, and employment.

Irrigation has been practiced in North Africa for thousands of years; however, Africa south of the Sahara is conspicuous for its lack of smallholder irrigation. Flood plain cultivation of river banks and shorelines of lakes where the water table is sufficiently close to the surface to provide adequate moisture is quite common. Yet even in areas of land scarcity little effort is usually made to dig shallow wells on land slightly farther from water sources. There appears to be widespread potential for smallholder irrigation on traditional holdings and in new areas as well. Both the paddy system and shallow





Threshing rice grown on newly irrigated land, Liberia.  
[Photo: FAO, G. Tortoli.]

lift pumps have widespread applicability. In the Casamance of Senegal, for example, low-land rice is cultivated only during the rainy season, even though farmers have little to do during the dry season when the water table is less than two meters from the surface. Bucket-lifts or the Egyptian shadufs could be used with paddy cultivation to produce another crop, if not of rice, then something else. River or stream irrigation also has potential. Flood water storage dams and inlet canals can be combined with primitive devices or even modern pumps to move water high enough to irrigate large tracts of land on either side of a number of rivers. Storage dams can be used in the more hilly areas while inlet canals have potential in some of the wide, flat river valleys such as the Senegal or the Gambia basins. Some irrigation from shallow wells is being

done in Chad, the Cameroons, and spots of Nigeria and is quite widespread in North Africa. Irrigation from mountain streams is being done in northern Tanzania. But these are still pockets of promise in an area of what appears to be vast potential. Feasibility studies on smallholder irrigation are needed for East and West Africa, both from a technical and an economic point of view; it will also be important to determine why such techniques have not been adopted.

#### Employment Generation through Rural Public Works Programs in North Africa

Public works programs utilizing PL 480 food aid for wages in kind have been in operation in Tunisia since the late 1950s and in Morocco and East Pakistan since the early 1960s. The objective is to alleviate unemployment and underemployment and, in the process, contribute to economic and social development. Investments under the rural works program are labor intensive and include land and water development, physical infrastructure and community development projects. Investment per worker is generally quite low as compared with investment per worker in industry. Unlike industrial employment, rural works programs can be tailored to the slack season in agriculture.

Topography and ecology are major determinants of the profitability of such projects. In all three countries, however, too great a pro-

portion of works expenditures have been on roads, other physical infrastructure, and community projects and not a large enough proportion on land and water development projects. Lack of effective technical back-up appears to be a major factor preventing a more economically desirable project mix in all three countries. A successful program requires well-developed local planning and administrative capabilities with good technical resource people. Rural works programs on a considerably smaller scale than those undertaken in the countries discussed might be better planned and better selected for their economic profitability. In areas with large rural populations that are essentially unemployed for four to six months a year, labor-intensive land development programs could make a substantial contribution toward increasing agricultural output and incomes, especially where irrigation development or feeder roads promise to alleviate existing bottlenecks.

It is virtually impossible to arrive at a judgment of the profitability of the rural works programs in Tunisia, Morocco, and East Pakistan from the available research to date. Conflicting conclusions are often published amid charges that the facts are misrepresented. But economics is more than production, and welfare more than output. Certainly, public works program alternatives must be viewed in a rigorous opportunity cost framework and their relative contributions to agricultural output assessed. But in deciding whether this kind of public works activity is desirable, it may be appropriate to assess the benefits of such programs in relation to their cost over and above a least-cost welfare program, for even where the output effects may be dubious the employment effects are certain.

[Excerpted from Employment Generation in African Agriculture. East Lansing (Mich.): Institute of International Agriculture of the College of Agriculture and Natural Resources, Research Report No. 9, Michigan State University, July, 1970, pp. 18-38. This report was financed by the U.S. Agency for International Development.]

## The Employment Implications of the Green Revolution

Robert D'A. Shaw

[The new high-yielding wheat and rice seeds clearly need more labor per acre in cultivation, though not necessarily per unit of output. But in areas unsuited to them their employment effect may be negative; and small farmers and tenants who cannot afford them may be displaced. Indirectly, they should also stimulate considerable employment.]

Since 1965, new high-yielding varieties of wheat, rice, corn and other coarse grains, have spread to parts of Asia and are beginning to be introduced in Latin America and Africa. The rapidity of the spread justifies the name "Green Revolution." This paper will concentrate on the new high-yielding dwarf wheat and rice varieties; these two foodgrains comprise the great bulk of the acreage under high-yielding varieties. Most of the studies on their impact have been done in India, Pakistan and the Philippines.

### Direct Employment Effects

The higher yields and the greater intensity of farming made possible by the new varieties appear to require a considerably larger amount of labor per acre for their cultivation. At the same time, though, the efficiency of complementary inputs, and particularly of fertilizer and water, is improved by use of the new varieties; as a result, the required labor for each unit of output is likely to decline. Thus, while yields may double, the labor requirement per acre is not likely to increase by as large a proportion.

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Wheat. The relatively sparse data available on wheat in South Asia support this reasoning. A survey of a wheat producing district of Delhi State in 1967/68 showed that use of the Mexican varieties involved a doubling of the family labor employed per acre and a small increase in the amount of hired labor; the gross return on these farms per acre nearly tripled. A report on Ludhiana District in the Punjab (one of India's most advanced wheat-growing districts) showed an increase in the number of jobs faster than the rate of growth of population and a 16 percent increase in real wages from 1962/63 to 1967/68.

Data from the Program Evaluation Organization of the Indian Planning Commission show that the participants in the high-yielding varieties programs for wheat have much larger expenditures for hired labor than do non-participants on the same size of farm. An average for the samples taken shows that participants on large farms spent about four times as much as non-participants, and that those on small farms spent about ten times as much. It is not clear, however, how much of the increase represented higher wages at peak labor seasons and how much reflected the additional hours of work required by the new varieties.

What stands out on examination of the yields achieved with the new varieties is that they are still low compared to what can be achieved. The average yield for the new varieties in India in the 1967/68 crop year was only 2,365 pounds per acre, though the range went all the way from below 2,000 pounds to over 6,000 pounds per acre. In West Pakistan the yields of the new varieties have averaged only about 1,600 pounds per acre. There is some evidence that an improvement in yields will require still more labor in cultivation--more careful preparation of the land, proper spacing of plants, correct fertilization, higher quality of weeding, and so on.

Rice. Rice is by far the most important crop in Asia, so an increase in the labor requirements of this one crop has extremely important implications for the whole region. The available information on rice is rather more conclusive than for wheat, though there has still been no comprehensive survey. With the exception of one study of the rice variety ADT-27 in Thanjavur District, Madras State (where most farmers used tractors for land preparation) the consensus of the material is that introduction of the new rice varieties does require the use of considerably more labor. In the Philippines, the most likely approximation of additional requirements is of the order of 30-50 percent. In India, the ratio of labor costs per acre for the high-yielding varieties and local strains varies considerably, from 1:1 in the case of Thanjavur all the way to 2.9:1 in West Bengal. The average is about 2:1, though it is not possible from the data to translate this directly into man-days/hectare. Nor is it possible to esti-

mate the degree to which these ratios reflect differences in the costs of labor and the influence of multiple cropping.

Below are some of the Philippine data contrasting the high-yielding varieties with local varieties.

	Man-days / Hectare	Man-days / Ton
<u>High-Yielding Rice:</u>		
IR-8, farm owner (1967 dry season)	85.7	18.9
IR-8, tenant (1967 dry season)	74.6	17.5
BPI-76, farm owner (1967 dry season)	90.1	24.1
BPI-76, tenant (1967 dry season)	78.3	25.4
IR-8, (1967 wet season)	79	16.5
IR-8, (1968 wet season)	69	18.7
<u>Local Varieties:</u>		
Local (1966 dry season)	53	22.5
Local (1967 wet season)	51	20.4
Malagkit (1968 wet season)	58	20.6

NOTE: All of these figures exclude time taken in harvesting and threshing, which can be estimated as adding another 20-30 days to the total per hectare.

The new rice varieties do not appear to use at present the same degree of intensity of cultivation as is practiced in East Asia, and especially in Japan. The rice varieties used in Japan and Taiwan differ genetically from those being developed in South and Southeast Asia, but they have similar characteristics of fertilizer responsiveness, requirements for water control, and careful cultivation and their history is therefore pertinent. It is believed that the Japanese labor input per crop of rice was as high as 370 man-days per hectare during the period 1910-25 when their improved rice varieties were diffused nationally. Subsequently, with the use of improved agricultural implements and more irrigation pumps, the labor input went down to 314 man-days in 1933-35. In the post-war years manpower was in short supply in Japan; the power tiller became a major factor and is now in operation on more than half of the farms in the country. Nevertheless, cultivation is still labor intensive; the official estimate for 1965 shows that rice cultivation consumed about 180 man-days per hectare per crop. In Taiwan, the National University has estimated the labor requirement at 150-160 man-days per hectare. These figures compare with a range of 60 to 120 man-days per hectare for crops of traditional varieties in most of South and Southeast Asia. For new varieties in the Philippines, the average is 100-110 man-days per hectare.

A major study by the Asian Productivity Organization shows how, in all the phases of the cultivation cycle except harvesting, more

labor is used per acre in East Asia than in South and Southeast Asia. Of special importance is the extra time spent in seedbed preparation, transplanting, and water control. Perhaps the new varieties being introduced into the latter regions may in time cause farmers to spend more time in seedbed preparation, etc., as the productive rewards become better understood. The average yields of the new varieties in 1967/68 were still relatively low compared to the potential demonstrated in experimental stations. These averages were as follows (in milled rice):

Philippines	2,591 lbs. /acre
India	2,400
East Pakistan	2,746
West Pakistan	2,472

These are the yields for the initial farmers adopting the innovations which generally represent the most favorable environments; as the new varieties have spread, their average yield has so far tended to fall. In comparison, demonstration plots at the International Rice Research Institute have produced two and a half times these yields.

The effect of multiple cropping. As the availability and the quality of controlled water supplies grow, the potential is opened for multiple cropping. This potential is enhanced by the fact that the new rice varieties mature so much more quickly than the local varieties. Double and triple cropping is likely to have a most significant effect on the employment and income opportunities open to Asian farmers. However, the shift from single cropping requires a major investment in irrigation and improved managerial ability. Both are made more worthwhile by the introduction of the new high-yielding varieties.

In those areas where multiple cropping is being made possible, the increase in employment seems to be roughly equivalent to the rise in the intensity of cropping. A study of some large farms in the Pakistani Punjab showed that because of the longer working hours per man per day, and also because of the increased numbers of workers (both family and hired hands<sup>1</sup>), the input of labor per acre on farms irrigated by tube wells averaged 57 percent higher than that on the farms without irrigation; this corresponded quite closely with the expansion of cropping intensity.

In Taiwan, the multiple cropping ratio on the island (that is, the ratio of the total area planted to the area of cultivated land) rose from 1.32 to 1.98 between 1915 and 1965. During that time, the total labor input measured in man-days doubled; as the number of agricultural workers grew by 50 percent the number of days worked by each person increased about one third, and the agricultural output per worker rose by 250 percent. The man-days spent per year on all farm operations on an average holding had reached 502 per hectare in 1962.



It appears, though, that the potential for multiple cropping in South and Southeast Asia is rather limited. According to a survey by the Asian Development Bank, the land suitable for the double-cropping of rice under existing irrigation is less than 10 percent of the total rice area of the region, and the present double-cropped area is only about half of that. This is mainly due to the quality of water control; the terminal water distribution and drainage facilities of many irrigated systems are inadequate for growing two or more crops a year, and many of them are too small to store enough water for the dry season. Thus, the opportunities for multiple cropping will have important effects on employment in only a few areas in the near future. Among these are Malaysia, which is relying on the expansion of its area under two or more crops to achieve self-sufficiency in rice, and those large portions of India and Pakistan where relatively cheap private tube wells and low lift pumps are both feasible and profitable.

In general we can conclude that the introduction of the new cereal varieties by itself does increase the demand for labor. It is impossible at this stage to obtain a firm estimate of this increase, though an overall range of 20-50 percent seems to be indicated by recent experience. The variations between regions are likely to be considerable. No areas in South and Southeast Asia appear yet to have attained the degree of labor-intensity on Japanese and Taiwanese farms; this raises the possibility of much higher levels of labor inputs and yields at some time in the future for those areas suitable for the new varieties, especially in conjunction with multiple cropping.

#### Employment Effects on Various Social Groupings

The direct effects of the new varieties on employment are not spread equally among the cereal farmers of Asia, partly because they are only suited to certain environments, but also because there are some economies of scale attached to their use. A third reason is that the agrarian institutions and social organizations in most of rural Asia tend to make it easier for large farm owners than for others to benefit from the Green Revolution.

Differences by area. The new varieties are suited only to certain environments found in a relatively small proportion of the total cultivated area in Asia. The main limiting factor is the environment's capability for providing adequate water supply and control. The irrigated area in Asia is being expanded remarkably rapidly; but for those areas that must rely for some time to come on rainfed agriculture, the cost reductions in production of new varieties under irrigation will work to their disadvantage. There will be relative price declines, and many small farmers who are in competition with the rice or wheat growers in irrigated areas may have to consider eliminating production of these crops for the market and concentrating on

subsistence production for their families, or diversifying into other crops. For the bigger farmers, there may be some opportunities for extensive farming on a large scale, making use of modern dry-land farming techniques and machinery. In both cases the number of employment possibilities is likely to decrease; the extent of underemployment on small farms is likely to increase.

Research into cereal varieties suitable for the drier areas should partially offset these effects. And diversification into cereals like sorghum and millet that are less dependent on large amounts of controlled water may also offer some hope. But, in general, the prospect is a relative and in some cases an absolute decline in the level of rural development in these areas. It is not possible at this stage even to hazard a guess about the magnitude of these effects. Government policies can do much to alleviate these inequities, but in the long term the alleviation of poverty in these areas depends on the transfer of significant numbers of people into environments where they can play a more productive role.

Differences within regions. There are four main groups within the areas suitable for the new seeds for which the benefits of the new technologies may be very different: large owner-farmers, small owner-farmers, tenant farmers and laborers. In many respects the new varieties appear equally effective on any size of farm; that is, they are neutral to scale. For the seeds themselves, for the fertilizer that is an essential component of their higher yields, and for other agricultural chemicals, all of which are divisible into very small units, this seems to be true. But some other aspects offer returns to scale unless these effects can be neutralized, principally mechanization, irrigation, credit and management. Large farms are in a position to make the best use of tractors, with the cost savings related to the size of the tractor. For irrigation, many of the old large-scale systems supply water regardless of the size of the farm. But for the most efficient units, the private tube wells whose use is spreading so rapidly throughout Asia, there is a minimum command area, varying from 25-50 acres, below which the costs of water rise sharply. The costs of credit are usually higher for small farmers than for large, because the risks are greater and because the same cost of administration must support a smaller loan; in some areas cooperatives and banks are reluctant to loan to small farmers at all. Credit is essential to most farmers to purchase the more costly inputs and to make the necessary investments in irrigation and equipment to utilize the potential of the new varieties. In general the complexity of farming increases with multiple cropping, new purchased inputs, and higher risks, so the required level of managerial skill rises. In the Philippines, for example, some very large farmers, with more than 250 acres, are finding it worthwhile to employ professionals to do their planning and management, and a new form of

management company is emerging to perform a similar function for groups of rather smaller landlords with adjacent lands.

The advantages possessed by large farmers for the initial adoption of the new varieties have been augmented by the tendency for government programs of agricultural development to concentrate their resources on the larger and more progressive farmers. This is hardly surprising for countries like India and Pakistan, which were struggling to overcome massive national grain deficits; by concentrating on a relatively small number of big farms, it was possible to have a more significant effect on overall output. But this approach can bring a number of employment problems in its train. The large farmers who were more easily able to adopt the new varieties increased their savings, and in many parts of Asia they have used these savings both to buy machinery that can displace labor, and to purchase more land. This trend increases the income base for those who are already well off. Another tendency noted in India, West Pakistan and the Philippines has been the emergence of a small but growing group of men, not previously engaged in agriculture, who are buying up farms and making a profitable occupation out of cultivating the new varieties.

Small farmers need more help than large farmers if they are to gain from the new technology. Those who have access to irrigation water and credit do appear to have made considerable use of the new high-yielding varieties, once their profitability has been effectively demonstrated. In such cases, employment of family labor and of hired labor for harvesting increases significantly. There is some variation throughout the region in the proportion of small cultivators who have planted the new seeds. For rice in India, the record has been very mixed, with the proportion of small farmers among participants in the high-yielding varieties programs varying from 13 to 70 percent. For wheat in India, however, a survey of the 1967/68 wheat crop showed a strong correlation between farm size and the proportion of cultivators participating in the high-yielding varieties program. In West Pakistan, too, it was noted that the Mexican wheats were first adopted by a higher percentage of large farmers than of small farmers, though in absolute numbers there are many more of the latter producing such wheats than large farmers. For those small farmers who are unable to make the transition to the new technologies, the prospects are bleak with the probable decline in cereal prices in the face of growing supply. Many of them will either retreat into subsistence farming, or take advantage of rising land values and sell out to clear their debts and attempt a new start in life.

The prospects for tenant farmers' adoption of the new seeds depend heavily on the prevailing patterns of land tenure in a particular area. As with small farmers, tenants and part-tenants face problems of scale in situations where they lack irrigation and credit. In

parts of the Philippines where landlords customarily share the input costs as well as the crops, tenant farmers seem to have been almost as ready as owner-operators to adopt the new rices. In contrast, barely five percent of the sharecroppers in the Kosi area of Bihar, India have used high-yielding varieties of seeds because arrangements are not nearly so favorable for tenants. In West Pakistan, even large farms operated by tenants tend to have a smaller percentage of adoption than small farm owners.

Tenants' difficulties are compounded by the rise in the value of land associated with the new varieties and their higher yields per acre. Tenants want to lease more land, while land owners are recognizing the gains to be achieved by direct management of their farms. All Asian nations have land reform laws, but the general level of enforcement has been low. Now that land is more valuable, landlords are very reluctant to get into a position where their tenants might be given title to the land. Numerous evasive tactics have been reported in West Pakistan, in India and in the Philippines. Some landlords have directly evicted their tenants who depended on oral agreements; others have prevented their tenants from establishing security of tenure by shifting them frequently. [See Development Digest, April 1970, pp. 23-28.] In the absence of more effective land reform, the prospect is for large numbers of tenant farmers to join the ranks of the landless laborers or migrate to the cities.

Landless laborers. In many areas of the Indus Plain where the Mexican wheats have been firmly adopted, the cost of labor as a percentage of the crop has doubled. Increased expenditures on labor as a direct result of the introduction of the new technologies have reflected both an increase in wages and in work opportunities for landless laborers. There has, as yet, been no distinct pattern to these increases, however, and the gains themselves may be of short duration. As their numbers rise through natural increase and the addition of displaced tenants and small farmers, the position of the landless laborers in rural areas may be expected to become more precarious. The growth of mechanization is also threatening the job possibilities for this group. Even where output is growing, these pressures have led to signs of a marked deterioration in the relationships between farmers and the laborers they employ.

Two Indian examples illustrate some of the factors involved. In areas where the Green Revolution has made a strong impression, and where the number of agricultural laborers is relatively small, their conditions have improved markedly. In Ludhiana District, Punjab, where landless laborers account for only 18 percent of all rural families, and where most were idle three or four months a year until recently, they are now able to find employment all year round by combining work in cultivation with some off-season work on the installa-

tion of tube wells, and land leveling, and also on the construction of roads and houses. In Palghat District, a major rice-growing area in Kerala state, on the other hand, 55 percent of the agricultural households consist of farm laborers, each of whom only works for an average of 180-200 days. Nearly all the rice land is already double cropped, but lack of suitable water control has limited the spread of the new varieties to about 10 percent of the gross cropped area. Agricultural laborers have seen little, if any, improvement in their living standards.

### Indirect Employment Effects

The new seeds, with their requirements for more and better inputs as well as increased outputs, should be a considerable indirect stimulus to employment. The production and marketing of seeds and fertilizer, chemicals and equipment will all create jobs, as will the processing and marketing of the additional grain. And there will be a further multiplier effect throughout the rest of the economy. With the present state of available material, it is not possible to make a guess about the overall increase in employment.

One area where there is need for specific policy directions is in the manufacture of agricultural implements. Sophisticated machinery such as tractors and related implements generally have to be made with large-scale capital-intensive machinery. Giles, for example, estimated that the number of jobs created by plants in Asia with the capacity to produce 12,000 tractors per year would be a mere 11,200. But equipment such as tube well materials and simple diesel engines, as well as plows and seed drills to be drawn by animals, can be manufactured more readily at the local level with vastly less complicated factories and skills. This has already been happening in those areas in which the Green Revolution has had its most significant impact. One documented example is the town of Dasca in the Pakistani Punjab: Dasca, with about 25,000 people, has grown into a center for the manufacture of simple diesel engines for tube wells and grain mills. There are now 105 small factories producing diesel engines from principally local materials, employing over 1,000 people who have been entirely trained in the factories as apprentices. There are numerous similar examples.

The whole area of marketing in the broadest sense will also provide new employment. Very large investments in storage, in feeder roads, in food processing and in distribution will be required in order to maintain the momentum of the Green Revolution and to market the increased output, and all of these investments will create jobs. For example, the bread baking industry in India has been growing very fast; in production alone, 92,758 people are employed as compared with 52,171 in 1961. At least part of this expansion



can be laid to the extraordinary increase in wheat production between 1966 and 1968.

One effect of the new varieties is to make the supply of staple foodgrains more elastic, more able to respond to changes in demand. It may well be, with the growth of the labor force, and with the impossibility of absorbing all the increase in urban jobs in the near future, that countries determined to face their employment problems will wish to engage in massive labor-intensive public works programs. Since a very large proportion of the wages of laborers so employed are spent on staple foodgrains, an increase in government spending on labor-intensive projects can sharply raise the demand for foodgrains. Programs of this type have been made easier by the Green Revolution because grain supplies are more likely to increase with the demand, and inflationary results become less severe. Such programs are not a long-term solution to the employment problem, but as a medium-term palliative they are an important tool of policy.

Finally, if the increased rural incomes from the additional cereal production are distributed fairly evenly, they should increase the demand for the kinds of consumer goods that can be produced domestically--textiles, furniture, utensils, bicycles, etc. These goods have the additional advantage that they can be made in relatively labor-intensive operations. And the employment generated in these industries will also help to augment the demand for food.

[Excerpted from "Jobs and Agricultural Development." Washington (D. C.): Overseas Development Council, Monograph No. 3, 1970, Chapter 3.]



## The Effect of Technology on Farm Employment in India

Martin H. Billings and Arjan Singh

[Projected trends for agricultural employment in Punjab and Maharashtra states in India give contrasting results from new technologies in different farming conditions. In Punjab both labor-using new seeds and labor-displacing machines will be widely adopted, with predominantly positive effects; in Maharashtra neither type of change is large relative to expected increases in the labor force and thus in underemployment.]

This study attempts to infer the influence of a group of associated technical changes in farm production upon the employment of agricultural labor over the period 1969-84 in the Indian states of Punjab (including the area now split off into the state of Haryana) and Maharashtra. The former represents the northern wheat-growing irrigated region and the latter essentially a non-irrigated millet area. The economic structure of agriculture in the two states is widely different; these two different situations are met with in extensive areas of northern and western India. The physical projection model developed in this study is based on our estimates as to the trends in farm working population, cropping patterns, rate of adoption of technological innovations and imputed rate of labor-machine displacement. The model makes use of a rather wide variety of data, some of which reflect local peculiarities in collection and interpretation. These factors may cause lack of precision, but we do not feel this will affect our conclusions. Our objective is to indicate directions of change; we are interested in relative levels, not in absolutes.

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### Brief Description of the Areas

Punjab, one of the leading agricultural areas in India, is mainly a flat alluvial plain with deep, fertile and highly productive soils. Although rainfall is not high, the state is well served by snowfed rivers and perennial canals, and has easily tappable sub-soil water for irrigation. About two thirds of the cropped area is devoted to food-grain crops, the most important of which is wheat, accounting for as much area as all other foodgrains. Cattle feed and miscellaneous crops account for another 20 percent. Among the non-foods, more important crops are cotton (6 percent) and sugarcane, rape and mustard, and groundnuts each nearly 3 percent. The staple diet of the people is wheat, supplemented with maize in central districts, rice in hilly areas, and millets and gram in the southern parts of the state. In 1961 Punjab had a total population of about 20 million persons of which some 20 percent lived in urban areas. About 35 percent of the population is in the work force, of which 63.4 percent is engaged in agriculture. Agricultural laborers constituted 12 percent of the total farm force in 1961 as compared with 17 percent in 1951; their number is showing sharp decline, particularly of women workers whose proportion among agricultural laborers fell from about 33 percent in 1951 to 11 percent in 1961.

Punjab is a land of peasant proprietors; 52 percent of the cultivators work entirely on their own lands, another 34 percent augment their own holdings with rented land and only 14 percent of the households are purely tenants. An average operational holding is about 12 acres; nearly 60 percent of the cultivating households operate farms larger than 7.5 acres and only 12 percent operate farms smaller than 2.5 acres. The process of consolidation of scattered and fragmented small fields into larger units has progressed in the state to cover practically all of the farmed land. This feature is of special significance in the Punjab agriculture, as it has given a strong impetus to the extension of irrigated area, land improvement and introduction of new technology. Industrial units in the state are generally small, dispersed and agro-based. The state is well served by roads and railways.

Since 1965 the area under HYV--the new high-yielding varieties of seeds--has sharply risen, in several districts exceeding planned targets. Wheat yields have doubled in the past 5 years, causing farm labor to be much more in demand than before. Farmers are responding to labor shortages and higher wage rates by substituting capital-intensive technology in critical activities, either where they are heavily reliant upon non-family labor or where yield-increasing opportunities are dramatic--notably mechanized water pumping. In 1969 there were about 142,000 diesel and electric pumpsets, 100,000 wheat threshers and 22,349 tractors in Punjab. These figures represent an increase of 11 times in pumpsets and five times in tractors

over the past 13 years. Wheat threshers have appeared only recently; in 1964, their number was estimated to be about 5,000.

Maharashtra is largely an undulating plateau with a number of rivers and valleys and a considerable variety in climate, rainfall, soil fertility and topography. Black soils predominate shading into red soils in the southern parts; both of these soils have poor depth and low level of fertility. On a vast tract, their productive capacity has progressively deteriorated as a result of unchecked erosion. Rainfall is low and highly variable. There are limited layers of aquifers in the sub-surface; irrigation has not developed to a degree which could significantly mitigate the natural soil and climatic disadvantages, in fact only 8 percent of the cropped area is irrigated. Consequently the crop pattern is dominated by jowar-bajra and such other low-yielding and low-value crops. Of the 19 million cropped hectares, nearly 33 percent is under jowar, 10 percent under bajra and 12 percent under pulses, all of which have rather lower productive potential than wheat and rice. Rice is the main crop in the wet coastal area. Commercial crops are mostly cotton (14 percent) and groundnuts (10 percent); where perennial irrigation is available sugarcane is grown, but its area is less than one percent of the cropped acreage. The multiple cropped area is only 8 percent of the total cultivated.

In 1961/62 there were 3.6 million operational holdings in the state covering an area of over 40 million acres. The average farm size works out to about 11.5 acres; however, 41.6 percent of holdings are in units of less than 5 acres and operate only 8.5 percent of the agricultural land. At the other extreme are farms of 50 acres and above, which account for 8.9 percent of the holdings but cultivate 36.8 percent of the area. As per 1961 census, Maharashtra had a population of nearly 39.5 millions, 28 percent of which was urban. Cultivators and agricultural laborers account for 46.1 percent and 23.8 percent respectively of the total workers in the state. The participation rate of women workers is very high, being about 46 percent among cultivators and 53 percent in agricultural labor. The proportion of agricultural laborers to total farm workers is 34 percent, which is nearly three times that of Punjab. Industrially Maharashtra is the most advanced state of India, but the concentration of industries is mainly in the Bombay-Poona region and a few other pockets. The rest of the state is predominantly agricultural, with poor land and meager, unreliable rainfall. Notwithstanding a relatively high degree of overall urbanization and opportunities in non-agricultural employment, the proportion of working force engaged in agriculture is high--about two thirds.

Not much success has been achieved in Maharashtra in introducing hybrid varieties of crops. The area under HYV of jowar and bajra was less than 10 percent in 1968/69. More than half of the maize area was under hybrid varieties, but this crop is not of much impor-

tance in the state and is consumed by the rural population only as a last resort when jowar and bajra are scarce. HYV of paddy are grown in irrigated areas, but cultivators in this state are accustomed to a protective irrigation system, using irrigation water only in the event of failure of rains. Tanks and seasonal rivers mostly supply water when rainfall is adequate and thus, unlike Punjab, this source of irrigation water is mostly non-perennial; this results in difficulty in using the intermittent assured irrigation which is essential for the successful growing of HYV. Nevertheless crop patterns and yields on rainfed lands could be improved substantially beyond the present level by soil conservation and scientific dry-farming techniques. In 1968/69 the state had 4,500 tractors, 300 power tillers, 4,500 power threshers and 247,000 diesel and electric pumpsets.

#### Data and Method

The measurement of the potential impact of important technological changes on farm employment was done by using a simple physical projection model. The projections for human population are based on estimates of the Planning Commission. From the total population, the labor force projections for the two states were made by assuming rates of increase or decrease in the 1961 Census participation rates by sex and broad age-groups. The farm labor force was determined as a residual from the total work force after estimating the rate of growth of non-farm employment, taking into account past trends and future programs of state non-farm development. Given the total strength of agricultural workers, the share of energy supply used for crop production was calculated after an allowance for time devoted by farm workers to other works, and time lost due to bad weather and sickness.

The requirement of human energy for crop production was determined on the basis of: a) expected cropping pattern over the projected years; and b) physical inputs of labor. The projection of the cropping pattern involved the estimation of land-use pattern by extrapolating past trends in total arable land broken up into two classes, irrigated and unirrigated, the former having been worked out from the projections by the Planning Commission and state plans. The projected cropped area for future years was allocated to different crops on the basis of percentages of each crop to total area as arrived at by fitting a straight line trend to the data for the period 1950/51 to 1967/68 and determining the limits of variation and optimal cropping pattern by using modified linear programming. Farm management and cost of production studies in the two states were used to estimate the per-acre labor requirements of crops for various agricultural operations. These figures were split up among the months according to the timing for performing various crop operations. The energy requirements of different crops and the total monthly requirements for the state were then worked out by multiplying the man-

days per acre times the numbers of acres under various crops and then adding them up.

In working out the proportion of area under HYV and the area irrigated by different sources (pumpsets, canals, etc.), we made use of the projections of the Planning Commission and our own estimates of the area under different crops. For tractors, their number and area likely to be covered by the end of study period were determined, taking into account the likely supply and demand position in future, as estimated by various governmental and other agencies, horsepower of the tractor units, present trends in their use and the pattern of farm operational holdings in the two states. A more or less similar procedure was followed for other mechanical devices, but in these cases we depended largely upon the estimates of experts close to the subject and our own observations, especially for items which have just appeared on the scene. Finally, the labor-machine displacement was estimated and its impact on human labor demand was calculated, mainly based on studies carried out in the two states.

#### Impact of Studied Technologies

Punjab. Seven technological changes have been considered for this state: HYV (assuming use of fertilizer), pumpsets, wheat threshers, tractors, cane crushers, corn shellers and reapers. None of these represents a sharp break from trends presently visible. HYV demand better irrigation facilities, which means intensive mechanized irrigation and later, mechanized threshing and harvesting. The HYV also demand faster seedbed preparation to gain full benefit from their shorter duration, and multiple cropping. Thus, the HYV are the thin end of the wedge which will very likely lead to the progressive mechanization of agriculture, although their initial effect is labor intensive.

The HYV with fertilizers are highly divisible and are a technology open to any farmers on rain-assured or irrigable acreage. Mechanical wheat threshers introduced recently are being used in the state very extensively; these are produced locally within a wide range of capacity and price. Their economies are so clear (about 4-5 times as fast as the traditional system) that it is a question of only a few years before almost all wheat will be so processed. Since these machines are available in different sizes to suit farmers of different scales, and custom service in threshing has become quite common in the state, this mechanical innovation could be regarded as neutral to scale. Extra yields of HYV of wheat have caused April to be a difficult month for harvesting. A market for rapid mechanical reaping has come into existence rather suddenly with the change in varieties, and some machines have already come into the market. A really suitable machine is yet to be developed, but by the later part of the decade there is reason to believe that such equipment will become commonly available and make an impact on production costs and the

Table 1: Estimated Extent of Technological Changes  
in Agriculture from 1968/69 to 1983/84

<u>Item</u>	<u>Punjab</u>		<u>Maharashtra</u>	
	1968/69	1983/84	1968/69	1983/84
I. <u>High-yielding varieties</u>				
Percentages of area under crops where HYV introduced:				
i) wheat	50 <sup>a/</sup>	95 <sup>a/</sup>	7	37
ii) paddy	20 <sup>a/</sup>	80 <sup>a/</sup>	9	60
iii) hybrid maize	15 <sup>a/</sup>	60 <sup>a/</sup>	50	90
iv) hybrid bajra	6 <sup>a/</sup>	60 <sup>a/</sup>	12	60
v) hybrid jowar	--	--	9	30
II. <u>Irrigated areas</u>				
Percentage of total cropped area:	50	66	8	18
Percentage of irrigated area by:				
i) pumpsets	24	60	27	35
ii) wells	22	4	41	17
iii) canals, tanks, etc.	54	36	32	48
III. <u>Power threshers</u> <sup>b/</sup>				
Percentage of crop threshed:	50	100	--	20
IV. <u>Reapers</u>				
Percentage of crop cut:	--	50 <sup>c/</sup>	--	--
V. <u>Tractors</u>				
Percentage of area expected to be covered:	3	20	0.5	5

a/ Percentages refer to irrigated area under given crops.

b/ In Punjab power thresher is used only for wheat. In Maharashtra it is for paddy, jowar-bajra and wheat.

c/ This figure is very speculative.

demand for labor. Though less neutral to scale than threshers, as the machine becomes common custom work will surely spread and its effect will be widely felt.

A tractor is a costly machine. Its supply is very much subject to public policy and its effect upon farmers and labor is conditioned by rather a wide set of policy and structural variables. Tractors in Punjab are owned largely by big farmers and by some medium farmers holding 15 to 30 acres; they use the tractors mostly for themselves. Several factors will condition the amount of time a tractor owner will be willing to rent out his machine: the size of his own farm, the risk



of wear from extra use in an area where service is a real problem, and his ability and readiness to make the necessary business arrangements. Some service, both plowing and transport, is being supplied at present, and more service is likely to develop with increase in tractor numbers, but the extension of custom service may be much slower than desirable for non-owners to be able to share in the benefits.

Maharashtra. The effect of four technological changes was studied: HYV, pumpsets, power threshers, and tractors. The other three innovations considered in Punjab, corn shellers, power cane crushers and reapers, are not of much importance in the state. Maize occupies only a very minor position in cropping, and only 7 percent of the sugarcane is now crushed with human and bullock labor. As for reapers, there is at present no visible indication of this machine gaining much ground in this state during the next 15 years, unless a cheap machine is evolved for cutting jowar-bajra which are the principal crops grown here. Wheat reapers, unlike Punjab, do not seem to offer much scope as the harvest of this crop in Maharashtra falls during the slack season.

The past performance of the state in introducing high-yielding varieties of crops has been much below expectation. In 1969, the overall achievement, in terms of area covered, was only 55 percent of the state plan targets. Various estimates are available regarding the future targets for HYV which were taken into account in our estimate; however, in the case of jowar, the principal crop, the recommended variety (CSH-1) is not finding much favor with farmers because of its susceptibility to shoot fly and poor eating quality.

Diesel and electric pumpsets are very popular in the state in spite of unfavorable conditions. They are extensively used for lifting water from rivers and streams which flow in all parts of the state, with greatly varying discharges in different times of the year, and their number is rapidly going up. Improved paddy threshers and machines for threshing wheat, jowar and bajra have appeared recently. By 1983/84, we estimate that nearly 1/5th of the total area under paddy, wheat, jowar-bajra will be mechanically threshed.

Due to heavy soil conditions and unirrigated extensive farming, the demand in Maharashtra is for heavy wheeled tractors of over 30 horsepower. In 1968/69 there were 4,500 of these tractors, and there were also 300 crawler tractors and 200 power tillers--with very little overall impact on labor. Heavy tractors are very costly and are mainly owned by large operators, by the state government or by sugar factories. Judging from past progress, it is estimated that by 1983/84 the state will probably have 45,000 wheeled tractors, 2,200 crawler tractors and 22,300 power tillers, commanding only 5.2 percent of total area.

## Results

Each of the new technology inputs has a separate and distinct effect on the demand for human energy. For convenience, emphasis is placed on 1968/69 and on the terminal year, 1983/84.

**Table 2: Changes in Demand for Human Energy:  
Effects of New Methods compared  
with Conventional Methods**

(in millions of man-days required per year)

<u>Cumulative Introduction of Technologies<sup>a/</sup></u>	<u>Punjab</u>		<u>Maharashtra</u>	
	1968/69	1983/84	1968/69	1983/84
1) Conventional	608.7	840.6	1546.5	1703.3
2):1. with HYV	644.3	952.0	1566.9	1819.5
3):2. with pumpsets	618.2	867.3	1563.1	1808.7
4):3. with power threshers	586.8	805.3	--	1790.4
5):4. with cane crushers	582.6	790.9	--	--
6):5. with corn shellers	580.5	771.9	--	--
7):6. with tractors	574.9	726.6	--	1767.2
8):7. with reapers	--	694.4	--	--
Net Change:	-33.7	-146.2	16.6	63.9
Percentage Net Change:	-5.5%	-17.4%	1.1%	3.8%

<sup>a/</sup> Labor requirements as shown in columns reflect changes resulting from adding one new technology after another, starting from the "conventional" base in which only pre-existing methods are used. The estimated shifts in labor requirements were: HYV 20-50% increase, by crop; pumpsets 1/4th of persian wheel; threshers 1/4th of indigenous method; cane crushers 1/5th; corn shellers 1/7th; tractors 1/5th of time with bullocks; reapers 1/5th of traditional.

Of themselves, the HYV appear to have increased the 1968/69 demand for human energy by 6 percent in Punjab and 1.3 percent in Maharashtra as compared to requirements for the same crops using traditional methods. However, pumpsets reduced total human demand in Punjab by 4 percent, threshers a further 5 percent and tractors one percent; overall demand is reduced by 11.5 percent. In Maharashtra reduction in labor demand by pumpsets (the only mechanizing factor considered) was negligible, being only 0.2 percent.

By 1983/84 farm machinery is expected to become a common feature in Punjab farm practices, when it seems possible that nearly 100 percent of wheat will be mechanically threshed, 100 percent of corn will be shelled by corn-shellers, 20 percent of the gross cropped

area tilled by tractors, 50 percent of the wheat crop mechanically reaped and 60 percent of the area will be irrigated by pumpsets and tube wells. These changes from the conventional technology are feasible if no radical changes occur in public policy regarding mechanization and if relationships between farm costs and prices remain sufficiently favorable. With these changes in the methods of crop production, total human energy demand in 1983/84 in Punjab will be reduced from the conventional level by 17.4 percent. The greatest displacement will occur in April and May, the harvest period, when demand will fall by 25.4 percent and 43.9 percent respectively. About 55 percent of the total labor displacement is caused by tractors and pumpsets, 37 percent by threshers and reapers, and the remaining 8 percent by corn shellers and cane crushers.

Maharashtra presents an entirely different picture. Only 20 percent of paddy, wheat and jowar-bajra are expected to be mechanically threshed, 5 percent of the area tilled by tractors, and pumpsets will command 35 percent of the irrigated area. The additional demand of human labor created as a result of growing HYV is much more than the counterbalancing effect of mechanical power in reducing labor demand. By 1983/84, with the increase in acreage under HYV, demand for labor will increase by about 116 million human labor days or by 6.8 percent. Pumpsets will displace 0.6 percent of the labor and power threshers and tractors 1.0 percent and 1.3 percent respectively. The net result will be overall increase in labor demand by 3.8 percent.

Table 3: Agricultural Workers per Cropped Hectare; Average Number of Days per Year per Worker Needed for Crops

Year	Punjab				Maharashtra			
	Cropped area (mil. hec.)	Agril. workers (mil.)	Workers per hec.	Days per worker	Cropped area (mil. hec.)	Agril. workers (mil.)	Workers per hec.	Days per worker
<u>Historical</u>								
1951	8.06	4.08	.51	n.a.	17.31	9.80	.57	n.a.
1961	9.73	4.54	.47	n.a.	19.09	13.25	.69	n.a.
<u>Projected</u>								
1968/69	10.46	4.79	.46	120	19.68	14.92	.76	105
1983/84	11.93	5.34	.45	130	21.05	20.47	.97	86

Table 3 presents the number of agricultural workers per hectare of cropped area in the states of Punjab and Maharashtra. During the period 1951-61, while the cropped area in Punjab increased by about 21 percent, the recorded increase in farm workers was only 11 percent, with the result that the average number of workers per hectare declined from .51 to .47. The ratio appears to be quite stable in the .46 to .48 range up to 1978/79, after which it decreases to .45; 1978/79 appears to be the turning point when the absolute number of agricultural workers will start to decline.

In Maharashtra, however, the density of cultivators and agricultural workers per hectare of cropped area is much higher than in the Punjab and is rapidly going up. An increase of 35 percent in the agricultural workers as against an increase of only 10 percent in the cropped area during 1951-61 resulted in worker/cropped area ratio increasing from .57 to .69. A similar trend continues throughout the projected period; the number of workers on farms will increase by 37 percent and cropped area by only 7 percent. This will result in the increase of agricultural workers per hectare from .76 to .97 or by 28 percent.

As changes occur in the average number of workers per hectare of land, the input per worker in terms of working days in a year also changes. While in the Punjab working days per worker are rising in spite of mechanization of certain operations, they are sharply declining in Maharashtra. In 1968/69 a worker in Punjab on an average worked for crop production for 120 days and in Maharashtra for 105 days. The corresponding figures for 1983/84 are 130 days and 86 days respectively, an increase of 8 percent in the working time of the former and a decrease of 18 percent in the latter. (In addition, a farm worker devotes as much as 45 percent of his total working days to farm work other than crop production such as tending of cattle, marketing of produce, purchase of inputs, etc.)

The nature of the shift in Maharashtra is consistent with what one might expect in small-scale family-centered farming, subject to rapid population growth. The additional 4.51 million fresh workers in agriculture, amounting to 22 percent of the total labor force in 1983/84, represent an increment of surplus above whatever surplus existed in 1968/69. Nearly two thirds of the additional labor force is estimated to be in the category of cultivators and the remaining one third as agricultural laborers. In the case of cultivators, disguised unemployment will grow markedly during the projected period; those who enter the work force will be absorbed in agriculture by work-sharing. A number of small farmers who lag behind in adopting new technology are likely to join the hired labor force. These and the additional surplus of 1.43 million agricultural laborers will substantially add to the number of workers in this class and thereby aggravate the already serious problem of underemployment and unemployment.

[Excerpted from a paper prepared for a conference "Employment and Unemployment in Near Eastern and South Asian Countries," sponsored by the Government of Nepal and U.S. AID, Kathmandu, Nepal, 6-9 July, 1970.]

## Agricultural Mechanization in South Asia

Ronald G. Ridker

[Several studies on farm mechanization in South Asia are summarized. While tractors and related gear displace labor on specific jobs, they can also raise output and create jobs by increasing cropping intensities; but they may not be the only means to this end. Alternative cropping patterns and institutional arrangements must also be considered in assessing results of these studies.]

The last few years have witnessed a significant shift in the literature on economic development. It used to be that top priority in terms of output and employment was given to industry as the dynamic sector whose growth was to pull other sectors along. Most of the policies following from this viewpoint--low food prices, emphasis on heavy industry, import substitution, and protection against foreign manufacturers--had the direct or indirect consequence of subsidizing industry at the expense of agriculture. A number of factors have changed all this: one consequence of starving the agricultural sector has been the need to import increasing quantities of food; an upward revision has been necessary in estimates of the speed with which population and hence the labor force has been growing; and third, the labor-absorbing capacity of the industrial sector has proved less than had been hoped, certainly less than needed. Finally, the advent of the new seeds (HYV) and cultural practices have capped this intellectual transformation. Among other things, this technology raises the hope that a solution to unemployment may be found in the countryside rather

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than in already overcrowded urban areas. But despite its potential, two nagging questions about the new technology have arisen: will it lead to more rather than less inequality in income and wealth; and if so will it, abetted by factor price distortions, encourage a form of mechanization that is labor displacing rather than labor absorbing?

The discussion here will focus on the second question. We are concerned with agricultural mechanization from several standpoints: what is its overall impact on employment? What effects will it have on productivity? How may its probable costs and benefits be jointly assessed in a South Asian setting? Several recent studies on the subject, and some of the discussions at a July, 1970 conference in Nepal which dealt with employment problems in the region, may be summarized.

Professor Khairullah Dawlati, in a paper presented to this conference, "The Effects of Tractors on Farm Output, Income and Employment During the Initial Steps of Farm Mechanization in Afghanistan" (mimeographed, 1970), supplies data covering more than a decade in three regions of the country. Tractors were all used on very large farms, and their purchase was in part subsidized. Their use was in most cases associated over time with increases--varying by region and by crop--in irrigated area, output, marketable surplus and net farm income. The farm labor force was reduced in numbers by about 7 percent (however, off-farm employment was no doubt increased by more than that). A more important change occurred in composition of the labor force; many renter-tenants were turned into sharecroppers and full-time laborers, the landlord keeping more of the management functions (and possibly returns) to himself. We may note that many other changes were occurring simultaneously with the introduction of tractors, but the economic results of tractorization can nevertheless be regarded as favorable. Such a conclusion is plausible in a country with a man-land ratio lower than average for the region, and where new lands can still be brought into cultivation.

Nowhere in South Asia, however, has mechanization become widespread. In Afghanistan we are talking about the effects of no more than 500 tractors imported over the years 1954 to 1966. Even in the Indian Punjab, only 20,000 tractors were available in 1968/69 for a total cropped area of over 10 million hectares. Far more important is what may happen to agricultural employment in the future, which is the topic of the Billings-Singh paper [see pp. 98-107]. For the Punjab, the authors project an overall reduction of 17 percent in the need for labor by 1983/84 as a result of the projected introduction of new seeds and mechanical innovations. For Maharashtra, while agricultural labor requirements are to increase because the positive effects of more intensive cultivation with new seeds will more than offset the substitution effects of a limited introduction of mechanical power, the agricultural labor force is nevertheless expected to in-



crease considerably faster than the demand for its labor. Thus, unemployment and underemployment can be expected to rise in both cases, unless the surplus labor is absorbed in non-agricultural occupations--as appears to be occurring in the Punjab. The disparity in these results suggests that similar projections for other areas will have to be undertaken before any general pattern begins to emerge.

A study of tractors in West Pakistan by S. R. Bose and E. H. Clark (*The Pakistan Development Review*, Vol. IX, No. 3, Autumn 1969) concludes that the social benefit-cost comparison for tractors is negative, and that such machines are inappropriate to a labor-surplus economy. The authors analyze the economic effects of progressive tractorization of all suitable farm lands in West Pakistan at various annual rates, computing first the direct costs and benefits to farmers at current prices (including gains from lower labor cost and replacement of bullock fodder with other crops; output per acre increases as a time trend only). These turn up generally positive for the farmer. The social costs and benefits--to the national economy--are then obtained by adjusting the farmers' figures to eliminate effects of the subsidies and agricultural price supports (a dominant element) and the taxes involved. Here the results are strongly negative: at a 12 percent annual growth in tractors, for example, the annual direct social costs by 1975 would be 330 million rupees compared to some 200 million in benefits. In short: tractors are profitable to farmers as individuals, but not to the nation as a whole. The authors also judge that indirect, non-measured, costs (resettlement of displaced workers, loss of meat and milk supply, disadvantages of local tractor production compared to animal-implement production) clearly exceed the indirect benefits (increases in mechanical skills and agricultural savings).

These conclusions contrast sharply with Roger Lawrence's in his recent study "Some Economic Aspects of Farm Mechanization in Pakistan" (1970, mimeographed). 1) He first analyzes the effects of introducing a series of mechanical devices in six stages on a particular wheat-cum-cotton sequence of cultivation on irrigated land in West Pakistan. Timeliness is a key factor because speed in harvesting winter wheat and planting spring cotton in a given field strongly affects cotton yields; it also affects the subsequent time of planting for wheat and whether the cycle can be completed within a year or must be interspersed with fallow and other crops (as is common). Costs are measured at current market values and also as "opportunity costs" based on scarcity values. The costs per unit of output measured in both ways were found to decrease continuously as mechanical devices were added, with an overall reduction of nearly 50 percent as compared to traditional methods. The labor requirement per acre with mechanical devices used remains greater than or nearly equal to the labor required with traditional methods up to the final and most mechanized situation in which combines are introduced, where it falls

to a somewhat lower level. 2) For wheat growing on rainfed soils, the use of tractors is even more favorable, largely because they make possible deeper plowing which, in certain soils, conserves the limited moisture available in much of West Pakistan; yields can be increased up to three times in some areas. 3) For rice lands in East Pakistan, on the other hand, power tillers can contribute neither strategic timeliness nor significant moisture retention. With labor and bullock inputs priced at market values, tillers can offer cost savings; but a comparison of opportunity costs (including labor and grass feed at zero) would put bullock cultivation under half the tiller cost per acre.

A few comments are in order. First, the effects of various innovations are treated separately in the Billings-Singh paper; the interactions among them which might make the sum of the parts greater than the whole are not fully taken into account. In particular, by increasing the speed of agricultural operations, tractors permit an increase in intensity of cultivation. The authors assume some increase in cropping intensity over time, but the rates were estimated on the basis of historic trends rather than related to the rate of mechanization. Given a specified rate of increase in cropping intensity, the addition of tractors will then be labor-displacing, as they indicate; but it may not be if appreciable additions to multiple cropping are induced by the mechanization. Lawrence's paper focuses on just these possibilities, using cases where data were collected in sufficient detail to show the results of using particular machines. Bose and Clark, however, cite a survey showing inconclusive results of mechanization on the productivity of land, and argue that animal-powered implements may have as great a potential as tractors. The question of whether there are other ways than tractorization to increase cropping intensity is an intriguing one. On the face of it there would seem to be no agricultural processes that could not be speeded up merely by using more labor and bullocks. The difficulties in applying this solution in practice have been that labor-management problems on large farms can become severe and that shortages of labor and bullocks are likely to appear during peak harvest and planting seasons. More investigation of alternative means of increasing cropping intensity, and possible barriers to each, is obviously called for.

Another neglected interaction which could be important for employment is shifts in crops as a consequence of mechanization. Some shifts were allowed for by Billings and Singh, but in the main these were based mainly on historic trends which may be invalidated by the mechanization. Thus if mechanization does in fact allow for an increase in multiple cropping, some land devoted to foodgrains could be freed for more labor-intensive crops. In addition, displacement of draft animals will release a certain amount of acreage under fodder (as Bose and Clark note) which could be used for more labor-intensive crops.

Many of the indirect effects on labor demand and supply were not assessed in these studies. An increase in farm income in general, and mechanization in particular, will lead to an increase in the demand for labor on two fronts: first, to produce, repair, transport and service an expanded range and quantity of inputs into agriculture, and second, to supply a wide variety of consumer goods and services. Within a local area some displacement of craftsmen may take place as demand shifts from traditional commodities to factory-made substitutes; this could be serious during a transition period that may last some time. But offsetting this will be an increase in demand for higher quality foods--fruits, vegetables and dairy products--all of which require more labor per acre to produce than do foodgrains. In addition, the increased income may actually reduce the labor force participation rate for women, thereby further easing the employment problem. Finally, the increased supplies of foodgrains resulting from mechanization will have a favorable, differential impact on the relative price of this important set of wage-goods, and make it possible to employ more labor generally throughout the economy with less inflationary consequences.

On the other hand, the increased use of capital for mechanized agriculture could mean less capital available for other employment-generating activities. If the same increase in cropping intensity could be obtained using more labor-intensive techniques, it may be better to use the capital elsewhere. But labor-intensive methods are not always the most economical methods; and in any event substantial institutional and political changes may be required to bring about comparable results. Furthermore, since the incremental capital-labor ratio in agriculture is still low relative to that of most other sectors, and since the availability of new techniques and machines for agriculture could induce an increase in the propensity to save among farmers, it is unlikely that such lost opportunities will negate the positive effects.

A final consideration is that all of these studies were made under the assumption that institutional conditions will not change in pertinent ways. But there are other possibilities: for example, a trend toward larger landholdings and larger-scale farm operations, noted by some observers in east and west Punjab as well as by Dawlati in Afghanistan, could accelerate. On the other hand, anti-landlord pressures might gain strength, forcing new land reform moves or stricter enforcement of existing laws. Another possibility is that seasonal labor shortages in particular areas might be met by short term recruitment of workers brought in from labor surplus areas rather than by mechanization. Still another relevant change would be a rapid activation of programs which give small farmers a greater access to new seeds and related inputs. The first change would presumably decrease labor intensity, whereas the latter three should bring about increases in the labor intensity of farm operations. Still another possibility is the develop-

ment of customized machine services which should help maintain the viability of small farms.

In sum, three broad categories of conclusions emerge from these studies. 1) Most forms of mechanization will displace some labor and bullocks applied to particular operations; but, because they can increase crop intensity and help conserve moisture in some circumstances, there are some offsetting positive effects on employment as well as contributing to output. The extent to which the positive employment effects offset the negative ones depends strongly on the particular mechanical device being considered (e.g., tube wells vs. combines) and the particular soils and cropping patterns to which it is applied. 2) There are a number of indirect employment effects on other sectors, most of which should be positive. Since the studies at hand do not measure these effects, the outlook for agricultural labor is likely to be somewhat more favorable than they indicate. 3) But the overall net effect will be strongly influenced by the prices and the institutional arrangements that prevail. If, for example, market prices were to be brought into line with true opportunity costs, if land ownership ceilings could be enforced, or if additional migration of labor during harvest time could be encouraged, forms of mechanization particularly detrimental to labor would be discouraged.

Beyond this little of a general nature can be said. The situation is so complex, and the possibilities so varied, that no overall verdict on mechanization is possible. Particular devices, used for particular crops in specified areas, must be considered on their merits in the light of the relevant institutional conditions and national objectives. Where so little is firm, a general policy approach worth considering is to correct price distortions and let the chips fall where they may, that is, to provide market signals reflecting true scarcities and let individual decision-makers choose whatever forms and amounts of mechanization they find to be in their best interest. This approach is not without its own set of difficulties, but at a minimum raising capital costs relative to labor costs so as to better reflect relative scarcities should help to deflect trends in useful directions where agricultural labor is plentiful and underemployment is a general problem.

[Adapted from a report on a conference  
"Employment and Unemployment in Near  
Eastern and South Asian Countries,"  
sponsored by the Government of Nepal  
and U.S. AID, Kathmandu, Nepal, 6-9  
July, 1970.]

## Toward Full Employment in Colombia

Inter-Agency Team organized by  
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[A full employment strategy for Colombia, as proposed in the first of a planned ILO country series, will require among other things a more dynamic agricultural sector; non-agricultural sectors cannot possibly provide all the projected 5 million extra jobs needed by 1985. A major effort should be devoted to land reform with employment creation as the leading criterion, and with high priority for "supporting services."]

The basic choice in a full employment strategy is how much reliance to put on different sectors as job providers. The various sectors show different levels of output per head, different rates of productivity growth (with different degrees of sensitivity to policy weapons), different possibilities in export and domestic markets and different import needs, different skill and professional requirements, different capital needs and different ways of financing them. Agriculture stands in sharp contrast to other sectors in many of these respects, and thus the degree of dependence on agricultural advance is a key decision. We made some simple quantitative estimates of the implications of various policies in order to get an idea of their feasibility. We started by examining a hypothetical pattern of output and employment that corresponds to full employment for Colombia at a future date, i. e., 1985, which involves 5 million extra jobs.

We then asked: what would be involved if all the 5 million extra jobs had to be provided outside the agricultural sector--broadly the strategy proposed by Dr. Laughlin Currie. Since there are now 2.5 million full-time jobs in the rest of the economy, employment there would have to treble, i. e., rise by some 8 per cent a year over these 15 years. Productivity in non-



agricultural sectors, taken together, seems to have been growing at some 2 to 3 percent a year. If this continues the hypothetical strategy under consideration would require a rate of growth of about 11 percent a year in non-agricultural output. Since the expansion of services depends partly on the rate of growth of agricultural output, their growth could not be as much as 11 percent. In consequence, a very fast rise in the output of the modern sector (mining, modern manufacturing, public utilities and transport) would be needed, perhaps a rate of some 14 percent a year--and this would have to be sustained for 15 years.

This strategy really does not look very feasible. It would be extremely difficult to find the capital and skills required to achieve this, especially if we assume that a large fraction of each has to be provided from internal resources, for political reasons if for none other. The rate of growth of the non-agricultural economy has been very roughly 6 percent in the period 1964-69. Such a path to full employment would also involve an even more rapid growth of urban population than in the 1960s. This would require very heavy investment in social capital. Accelerated urbanization would bring to Colombia even more rapidly the problems found in all of the world's big cities. We concluded that Colombia's great asset, spare land, must be exploited, and that the agricultural sector will have to provide many of the 5 million jobs that are needed.

It will be impossible to solve the unemployment problem unless the rural economy, and more specifically the agricultural sector, becomes much more dynamic than it has been in recent years. The number of jobs needs to grow more rapidly than it has been doing, and productivity growth needs to accelerate, partly to raise the very low incomes in this sector. Allowing for both employment and productivity, the rate of growth of agricultural output needs to be stepped up from between 3 and 4 percent to between 5 and 6 percent a year. This would be necessary, from another viewpoint, in order to meet the food requirements of the growing population, for which they would increasingly be able to pay as employment and incomes rise in other sectors, while at the same time contributing to the export drive which is required to pay for the growing import needs of all sectors. Higher rural income is also needed in order to widen the market for manufactures, both consumer goods and agricultural inputs.

#### Land Tenure

These objectives involve a complete transformation of the prevailing state of affairs and a reversal of previous trends, and it cannot be achieved without many institutional changes and a big government policy effort. The agricultural economy is at present shackled by archaic organization. There is land not being cultivated; at the



same time, hundreds of thousands are crowded on tiny plots (many of one hectare or less) which do not provide them with even a decent subsistence, let alone any opportunity or incentive for technical progress. While there are many medium and large farms which are run efficiently and show a rapid rate of progress, the bulk of the rural population is living socially and technically in an earlier century, using crude manual tools and primitive ploughs with animal traction.

The heart of the agrarian problem can be grasped from an aerial picture. In the central area where 97 percent of the people live, the mountainous Andean regions with poor soil are for the most part dotted with small individual homesteads, reaching down into deep gorges and up to the ridges. An immediate impression is conveyed of the vertical distances which farmers must travel to buy and sell when their needs go beyond mere subsistence, of the steep topography on which they cultivate, and of the tortuous roads on which everything has to be transported. Among these small homesteads are larger holdings devoted mostly to grassland and livestock. Perched on convenient sites are a number of market towns. Away from the mountains, as the river valleys with their richer soil broaden out and slope northward, the holdings are much larger, devoted originally (and to a large extent still) to extensive cattle-raising, but since the Second World War increasingly utilized for modern commercial farming producing sugar, corn, soya, rice, cotton, bananas and beef for the domestic and export markets. One also sees a large portion of the lower Magdalena Valley as mere swamp, the flooded land being increased by erosion from the overcrowded mountain regions of Santander and Boyoca, and one sees, of course, the big towns of Bogota, Cali, Medellin and others, and the lesser towns on the coast, all of them termini of urban drift. Altogether outside this central area, and by comparison uninhabited, are the steep forested slopes of the Pacific coast and the immense eastern plains stretching down to the Orinoco and Amazonas rivers.

The historic origin of these marked differences in land usage and subsequent population pressure is said to lie in the fact that in early years people preferred to settle in the mountainous regions as the lower lands were malarious and swampy, and this tendency was accentuated when coffee became the major crop of Colombia. Meantime, the lower lands came to be acquired in very large parcels by wealthier elements in the population and used for extensive cattle grazing. The curious result has been that it is the poorest lands which have come to be the most cultivated and used for arable purposes, while the richer lands have been far less cultivated. By contrast, planning for optimum usage might be expected to preserve the highest and steepest slopes for forestry in order to stop erosion and safeguard the watersheds, devote the poorer lands mainly to grazing and use the richer lands for arable purposes. This is one, absolutely central, respect

in which adoption of the new objectives would imply a reversal of past trends. But this cannot be done without changing a distribution of land which reflects past patterns of land use.

The quality of land varies greatly: while some of the large holdings are good arable land, the majority are not. Coffee, suited to the higher altitudes, provides for the smallholder a crop with a high yield per hectare. The overall pattern, with tens of thousands of smallholders growing coffee, is thus markedly different from that in Ecuador or Peru, for example. There is nonetheless a very inequitable distribution, with the majority of the rural population living on farms too small for a family to cultivate efficiently. A summing up of the nationwide picture in 1960 is that approximately 45 percent of the cultivated and pasture land was in the hands of 1.2 percent of the people and that 65 percent of the people (approximately 58 percent farmers or sharecroppers and 7 percent landless) were on 5.5 percent of the land. The situation is somewhat mitigated by two developments. The first is that coffee, far and away the most important export and mainly grown on smallholdings, is currently enjoying a boom. Secondly, many thousands each year brave the hardships of hacking out new farms from the wooded eastern slopes of the cordillera. But neither of these is in any way a basic solution. The coffee boom is temporary and affects only certain areas (and does not, even in 1970, provide an adequate income there for the smallholder). And there is a limit to the numbers of Colombian peasantry who would feel inclined (in today's world) to put themselves and their families at a frontier of agricultural expansion.

Professional opinion seems to be cautiously coming around to the view that "very often a reform of land tenure institutions can be a stimulus and even a necessary condition for technological progress in agriculture," to quote from the conclusions of a worldwide U.N. survey of the subject. Certainly, a large number of reports on Colombia have stressed the need for reform, with greater or less emphasis, starting with the World Bank mission of 1949. This mission pointed out that there is a basic paradox in a situation where livestock roams fertile plains, while peasants are huddled in hillside pockets. Some of the big landholdings are very efficiently managed, but others show little evidence of management at all. In agriculture, where minimal upkeep costs (rural wages being what they are) need not be large and taxation is low, if it is collected at all, there is no evolutionary pressure to eliminate the least fit. Some striking comparisons based on the study by the Inter-American Committee on Agricultural Development (CIDA) show: first, gross value of output per hectare of agricultural land was more than ten times as great on the sub-family farms as on the "large" farms. Secondly, 80 percent of the smallholders' land is under crop, as against 33 percent for the largest holdings; even taking land under crop as the criterion, out-

put per hectare is on the average higher the smaller the holding--though we must always bear in mind that averages can be very misleading, some of the big farms being very efficient. In these circumstances, land reform would have to go very far wrong to check the growth of output, even temporarily, and there are measures one can take to prevent it from going wrong. The long-run potential effect of a large program of land reform could be considerable, not only for employment, but also for output.

[Analysis of postwar land reform experience omitted. The authors conclude:] The scale and nature of land reform are critical and urgent questions. To decide them properly demands much more detailed inquiry into just what land is available for family farm settlement through irrigation, colonization and redistribution, and what prospect in the rate of progress and accommodation of people these avenues can provide, as well as what rate of progress can be expected from improved small farm production from present sites. Such an inquiry is one of the first needs for planning strategy. INCORA (Colombian Land Reform Agency) has been in existence only a relatively short time and has had to feel its way, to find out from experience what policies are too costly and to justify its future priorities to its financial sponsors.

Land reform must be pursued with all due deliberation--but not without speed, and INCORA needs to become a more dynamic instrument. A very high priority is needed for supporting services. The program should aim to avoid thwarting the dynamic drive of the efficient large commercial farmers because of the vital contribution they can make to exports and town food supplies. Subdivision of land should be carefully judged with employment creation as the leading criterion--which may, for example, imply that, when a large estate is taken over, room should be found on it for more people than those previously working there as wage earners. Finally, care has to be taken over the organization of new settlements--whether these are the result of redistribution or irrigation schemes or colonization. There is a great range of possibilities, and the pattern should be chosen which seems most suitable for the case in hand.

### Agricultural Production

Land reform is a necessary element in the strategy, but by no means the only one. The whole sector needs galvanizing into activity, including those unaffected by land reform, if it is to play its role in an employment strategy. One possible policy is to encourage the development of large and medium-sized modern commercial farms to produce all the requirements of export and domestic markets. The case for this choice is that in richer, more developed countries the trend is for this kind of solution and for the elimination of smaller

farms which by comparison are less economical in production per man-hour. It is much easier and less costly to the state, and much quicker in raising the growth rate, when private entrepreneurs can be encouraged to put their own enterprise and capital behind such a strategy. If this is the correct ultimate destination for the countryside, then why not aim for it right away, and discourage small farms?

This choice, however, depends on the assumption that everyone who cannot find a living in or through such a farming system can be accommodated in the industrial and service sectors of the economy, a legitimate assumption in a rich developed country, but by no means in Colombia. Hundreds of thousands of additional jobs need to be found in agriculture. The chances of doing so through large modern commercial farms are negligible. It is not merely the future labor force, moreover, that we are concerned with. The situation already existing in the countryside means both social cost and economic loss when a high proportion of the rural masses have only very small farms which can neither provide them with an adequate living nor with the purchasing power needed to develop an adequate domestic market.

We believe therefore that a very different form of strategy is demanded, one which can give far more people in the rural areas an opportunity to participate in commercial production for export and domestic markets from family-sized farms. This strategy implies reserving the opportunity to acquire land to these people and for this purpose, rather than encouraging its acquisition by those with enough capital, and it implies switching resources and incentives to make this section of the rural population commercially productive. We believe this strategy to be an immediate basic need in development which should call for the support of all agencies, both public and private, foreign and international. In our view, the tendency of large commercial farming to capture the export and domestic markets might relegate the mass of rural people to continued poverty, increase the present great inequality in income distribution, curtail employment opportunities, and forfeit the use and potential purchasing power of considerable human resources. The effect on stability might endanger investment in all other sectors. However, a balance has to be kept between economic growth and greater participation by small farmers in commercial farming; the latter process is likely to take a long time. We see no purpose in breaking up and redistributing large farms which are being presently utilized effectively and are contributing to maintaining the growth rate. (The situation and our implied strategy in the industrial sector are very similar to that for agriculture. There too the danger lies that modern capital-intensive industry will capture the whole of the domestic and export markets.)

Demand. Imports of foodstuffs are now very low, so the first prospect to be considered is the pace at which demand for food will grow. Population growth sets a floor to the projection of demand of about 3.5 percent a year. Since, very broadly, demand for food grows at half the pace of per capita income, we would expect, on our strategy, about another 2 percent--certainly not much less is needed to make any impact on undernourishment in the coming years. That makes 5.5 percent. The effect of redistribution is very difficult to estimate--the final result might be 6 percent. So, broadly speaking, domestic demand would grow fast enough to keep pace with a food production growth which could suffice to expand employment satisfactorily after allowing for productivity increases.

On the other hand, agricultural exports can hardly grow as fast as this--at least for some years--because of the sluggish world demand for coffee. The obligations of the International Coffee Agreement, and the capacity of many countries in the world to increase production, imply that it will be subject to export quotas related to the long-term growth trend of world consumption. Diversification in favor of other, so-called minor, exports has been a major feature of government policy for some years, with some success. Sugar, cotton, bananas and cattle represent more than 50 percent of the total earnings from these minor exports. The outlook for sugar is very much dependent on the quota that can be obtained in the United States, since the current world price barely covers the Colombian cost of production: prospects are thus restricted. Exports of cotton, a crop with a spectacular increase in recent years, may also run into difficulties because overseas demand depends increasingly on a quality and staple length suited to blending with artificial fibers. On the outlook for bananas, one must be equally guarded because growing world supplies are expected to weaken prices. The long-term potential demand for cattle, especially beef, is substantial and Colombia with its impressive pasture resource has a clear opportunity here; unfortunately, however, livestock production is, from the employment point of view, far less labor-intensive than crop production. The somewhat limited prospects of these products has led the government to encourage other potential avenues, particularly rice, corn, sorghum, palm-oil and timber. There are other possibilities: export opportunities to industrial countries may lie in catering for out-of-season fruits, flowers, etc., which are labor-intensive and can be transported by air. All this adds up to a diversification of crop production, both for exports and for meeting domestic demands as incomes rise.

Marketing. The ability to keep down the costs of production will be an important factor in developing and holding markets, as well as the ability to deliver the right quantity, quality and packaging to meet contracts. In the first respect the utilization of family rather than hired labor may have its advantages, for the family farmer can tighten



his belt more easily than the entrepreneur with his payroll; but in the second respect a major organizational effort would be needed. A government agency (Instituto de Mercadeo Agropecuario) was set up to improve marketing and operates price supports for a wide range of crops, but the beneficiaries so far have largely been the modern commercial farmers; the agency should concentrate more on the problems of the small farmers henceforward. An improvement in the marketing arrangements such as has been organized for pineapples by the Coffee Federation is needed before a small man can risk diversification.

A first task for forming a strategy might be to determine which areas are most suited ecologically for the production of those products likely to meet a market demand, and a second task to establish within those areas pilot projects where the necessary ingredients such as labor availability and accessibility to market are most easily obtained, and where a satisfactory marketing system can be tested and established. A third task might be to prepare good projections of future supply and demand. As a way of meeting objectives progressively by stages and avoiding too thin a spread of scarce resources with no subsequent impact and a risk of a kind of "bottomless pit" wastage, we believe that consideration might be given to locating such pilot projects initially in what might be termed pioneer areas where the full process of rural development strategy could be applied.

Research and extension. Once a small farmer sees a market opportunity he needs to know how he can increase his profit by getting the maximum yield from his products at minimum cost. The usual ingredients are higher-yielding varieties of seed, tree or animal; better feeding for the crops by means of fertilizers and manure and for the animals through improved pasture and concentrates; and better disease control--the whole combined in the most suitable rotation and farm plan for the locality. The process requires research to discover the answers, extension to pass them over to the farmer, access to the required inputs and credit to buy them. An essential feature in obtaining high yields is that these ingredients are like links in a chain; if any one link is missing, the chain breaks and the investment in the other links may be partly or completely wasted. Very valuable research leading to improved varieties has been done for some years, but mainly on individual crops such as sugar, cotton, barley, rice, wheat, potatoes and tobacco. The value added by all this research has been vastly greater than expenditures on it. Very little research, however, has yet been devoted to treating the farm as a whole, which is particularly what the small farmer needs.

In order to provide a research-extension link, an agency (the Instituto Colombiano Agropecuario) has been charged since 1967 with overall responsibility, as far as the government is concerned, for



research, extension and agricultural education. So far ICA has organized 52 extension units, each with one agronomist, one veterinarian, one home economics worker and five "practicos" (medium-level technicians), the latter being the actual contact men for the farmers. The main body of the official extension service thus comprises 150 professionals and 60 "practicos." This team approach comes closer to the objective of treating the farm as a unit; and the system of having "practicos" who can learn comparatively quickly simple rules for passing on to farmers, but backstopped by professionals in their own service and at the research stations, should provide the desirable two-way link whereby discoveries of research can be better diffused and problems arising on the farm can be referred to professionals for solution. In a country very short of professionals the system has a chance of getting some service going quickly. The numbers involved, however, are infinitesimal compared with the need. There are approximately 1,500 professionals and 1,500 "practicos" in all the government agencies and producers' federations, and as many of these, with the exception of those of agencies like the Land Reform Agency and the Coffee Federation, mainly serve the modern commercial sector, the numbers available for the small farm sector are very low. For effective use a choice thus arises as to whether to spread these services widely and thinly or whether to concentrate them in the kind of pioneer area strategy proposed above.

Quality as well as quantity determines success in extension. In this respect countries where status and facilities for education are associated with urban life, as they are in Colombia, run into a constraint over quality for service in the countryside, in that often the only available candidates are students who have not been able to pass in other courses and have only a marginal interest in agriculture. To the extent that farmers' sons, or farmers who have lost their holdings, can be found with high enough educational standards to be recruited as "practicos," these disadvantages might be reduced.

Production inputs. The next link in the chain concerns access to inputs and the credit with which to buy them. A first general point in connection with access is the topography of holdings in the mountain areas, and the remoteness of the colonization areas. Investments have been made first in communications between the main cities, in the commercial farming areas and in improving the ports; very good main roads exist for these purposes. Access to inputs and to markets are inevitably restricted by the lack of feeder roads in rural areas, which raises the cost and lowers the farmers' profit in both directions. A labor-intensive campaign for constructing feeder roads is thus an obvious target in strategy, and one which appears more urgent than problems of availability and production of the inputs per se.

An important principle in an employment strategy for agriculture is that technical progress should take the form of improvement in the

techniques of cultivation (seed selection, fertilizers, etc.) rather than of increased mechanization, which has on occasion in the past simply doomed labor to unemployment--even though it may play an essential part in raising smallholders' incomes.

Credit. In Colombia there are three kinds of banking service available to agriculture: commercial banking which supplies the large operator; intermediate banking in which government departments and mixed public-private companies cater to a middle class of farmers; and what might be called "rehabilitation banking" for the peasant and sharecropper. Commercial banking need not concern us here. Intermediate banking was started in the 1920s, and today the Caja Agraria, and similarly the coffee bank and livestock bank, are doing extremely useful work for the medium and larger farms. But those most in need get little chance of qualifying for credit at all.

Rehabilitation banking has been started as an effort to meet the problem of the small farmer who really has no security to offer except the potential increase in production which the borrowed inputs may provide. INCORA has taken the initiative in instituting a supervised credit system linked to extension and other inputs and, where possible, to marketing contracts. The system has only extended so far to 2 percent of the small farmers, but it has been reasonably successful as an example of the linked package approach. The World Bank has recommended its extension and inclusion in the program of medium-sized farms so that all farmers in an INCORA project come under the same system. One reason for this comparative success has been the decision to put the weight of investment into providing adequate numbers of field staff in touch with the farmers. The "practicos" in this case average one per 55 families, with one agronomist for every four "practicos." These figures are in striking contrast with those for other agencies. Funds from the World Bank are conditional on an associated training program. Also INCORA has sponsored in cooperation with SENA, the government training agency, courses in improved agriculture affecting some 20,000 small farmers.

Farmers' associations. The cooperative movement in Colombia is of recent introduction. In 1953 there were only four cooperatives whereas by 1968 there were 1,826. Since then there has been a falling off, some of the societies having proved uneconomical. The government has recently set up a superintendency of cooperatives to clear up the movement by weeding out the bad ones, and there is a three-year plan to reinvigorate it and attain a target of 4,000.

A future pattern well worth consideration would be the type of farmers' associations (multi-purpose cooperatives) which have proved so successful in Japan and Taiwan in demonstrating that small-scale farming can produce high yields and satisfactory incomes. There may be very big advantages in establishing farmers' service centers within

reasonable distance of the surrounding farms, and where possible in the local small town, where a farmer can get all his needs in extension, inputs and credit under one roof. It is particularly at the local level, where the farmer needs these services as a package in one place and at the right time, and where the buildup of his own association and participation must be clear to him, that the prevalent confusion may be damaging. Conflicts of authority, the fact that the provision of credit is divided up among the agencies, and reference to different people in different places for different needs may be a cause of delay and enfeeblement so that the benefits expected from programs may turn out to be disappointingly slight. Such centers could serve also as delivery points for marketing and develop as the headquarters of a farmers' association. [See Development Digest, April 1970, pp. 55-64.] Another feature which might be considered is the establishment of farmers' training centers in the vicinity of some of these farmers' associations. These training centers could illustrate the techniques, the costs and profits involved, and could also be used for training "practicos."

Another task in the strategy is the need to encourage private enterprise of all types to come in as an ally in the rural development program, so that the government does not have to carry the burden alone. Private enterprise is already involved but mainly in the modern commercial farming. The problem is to see how far it might help to improve the situation of the smaller farmer. A successful system of farmers' associations could make new contact points for sales in a sector where little opportunity is presently offered or will be as long as farmers are simply poor individuals. Where such systems exist, bulk contracts are made for the purchase of a variety of inputs like seeds, fertilizer, pesticides, tools, pumps and small trucks, for the sale of products from the farms and, when some purchasing power has been gained, for retailing consumer goods. Private enterprise should be able to offer commercial expertise in management, technical assistance and ingredients for improving productivity in crops and livestock, and particularly in exploring markets and the conditions as to season, quantity, quality and packaging needed to capture them.

[Excerpted from Towards Full Employment. Geneva: International Labor Office, 1970, pp. 51-54, 65-71, and 76-91.]

U.S. GOVERNMENT PRINTING OFFICE: 1970-434-895/2

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